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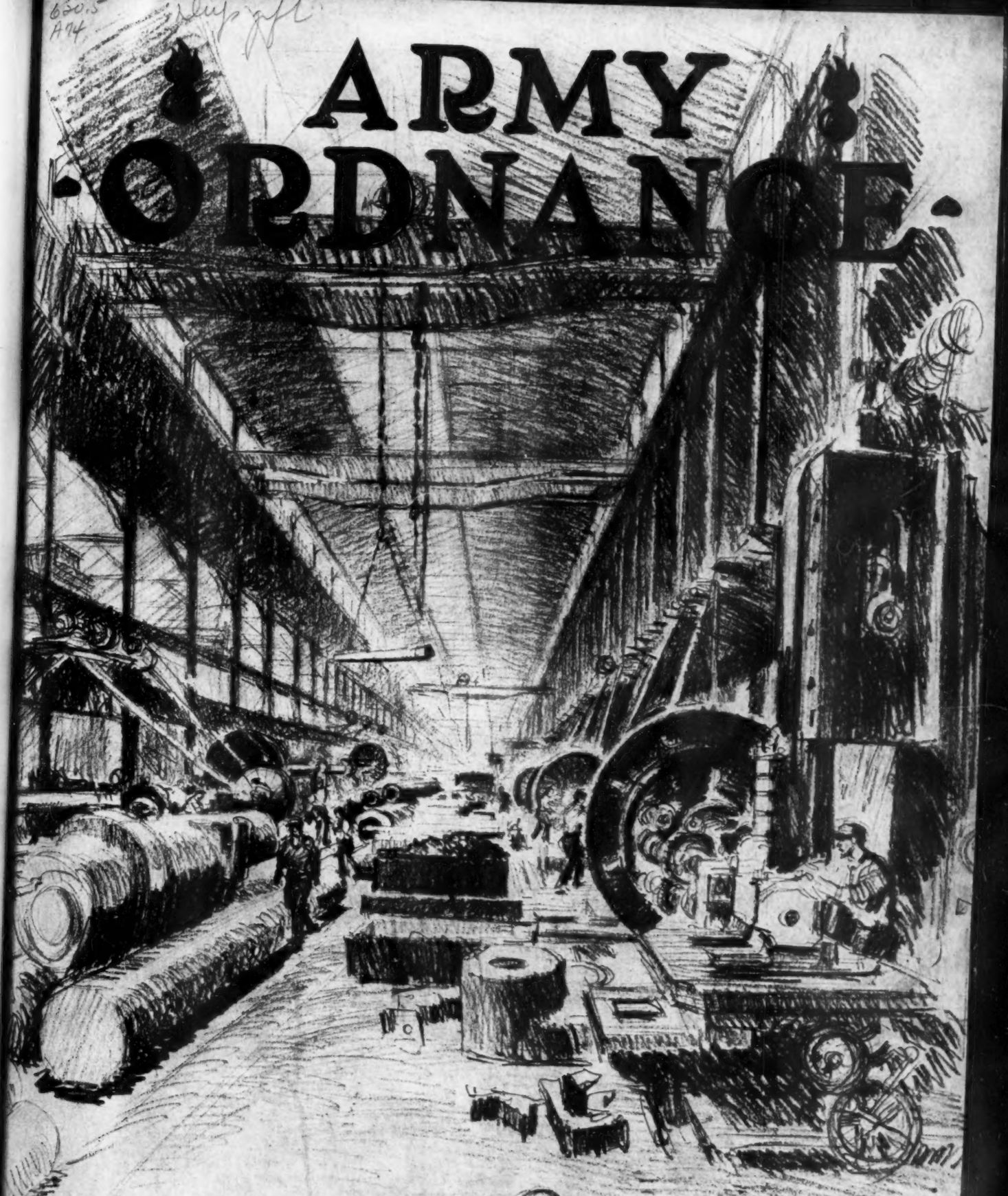
# ARMY ORDNANCE



THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

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# ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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"Our national-defense doctrine involves the maintenance in time of peace of the minimum force necessary to hold off any aggressor until the country could prepare itself to wage war. Today our land forces are reduced to a level that requires the utmost in preparatory measures to facilitate the application of our vast resources to war uses, if ever this extreme action should become necessary."

*General Douglas MacArthur.*

# The Army Ordnance Association

THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guarantee of peace.

The Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

THE Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times coöperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace insurance" in this form is the foremost aim of the Army Ordnance Association.

The Association is purely patriotic; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American scientists, inventors, engineers and manufacturers in civil life and the regular and reserve officers of the Ordnance Department.

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.


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Col. David M. King, Ord. Dept., U. S. Army

Commanding Officer, Rock Island Arsenal

Died January 27, 1932

ARMY ORDNANCE

VOL. XII JANUARY-FEBRUARY, 1932 No. 70

# Col. David M. King

## *1869-1932*

IN the death of Col. David M. King, Ord. Dept., U. S. Army, on January 27, 1932, the Ordnance Department and the nation lost an outstanding soldier and citizen. Long acknowledged a leader in his profession, Colonel King was an officer of the highest ability whose kindly bearing and tireless administrative powers won for him the admiration of his fellow-citizens, the respect of his associates and the commendation of his country.

Closely identified with the progress of the Rock Island Arsenal for many years, he had served as commanding officer of that great establishment from June 3, 1921, until his death. In length of command there he exceeded the terms of any of his predecessors including such well known names in the history of American Ordnance as Rodman, Flagler, Buffington, Blunt and Burr. He was definitely a part of America's premier arsenal and to it he gave his best talents and service. Under his guidance it held high place in the roster of leading ordnance establishments here and abroad. The passing of this great soldier leaves his name written indelibly in the record of American munitions and no less lastingly in the hearts of his many friends, particularly those of the Army Ordnance Association of which he was a charter member.

Colonel King was born in Smyrna, Ohio, November 5, 1869. He was graduated from the United States Military Academy in June, 1893. His first station as an additional second lieutenant of the 4th Artillery was in Washington where he served until 1896, in which year he was appointed an instructor at the Military Academy where he served until 1899. In 1898 he was commissioned first lieutenant, Ordnance Department.

ADVANCING through grades and serving at various ordnance establishments in the intervening years, Colonel King, upon the entrance of the United States into the World War, was on the staff of Colonel Burr at Rock Island. He was soon designated by the Chief of Ordnance to design, equip, construct and obtain the necessary commissioned and enlisted personnel for the maintenance of all ordnance matériel in France. This was a $20,000,000 project and required approximately 275 officers and 20,000 skilled enlisted men for the operation of the shops and repair facilities. The main shops were located at Mehun, France, and about 9,000 men were employed there at the date of the Armistice. Some 20 smaller plants were established, maintained and operated at artillery training camps and elsewhere in France.

For his war service Colonel King received the Distinguished Service Medal with the following citation: "For exceptionally meritorious and distinguished services. Displaying exceptional technical knowledge and comprehension of existing conditions, he ably organized, installed and operated in the Services of Supply, and in the Army area, an extensive chain of repair facilities for the maintenance of ordnance material. With tireless energy and unfailing devotion to his important duties, he perfected a loyal and efficient organization, capable of meeting all demands made upon it." The French Government, in recognition of his war service, made him an officer of the Legion of Honor.

Upon his return to this country in 1920, Colonel King served as head of the Administration Division, Office of the Chief of Ordnance, until his appointment as Commanding Officer at Rock Island.

ONLY recently Colonel King was the recipient of congratulations upon his citation by the Inspector General of the Army for the high state of efficiency of the Rock Island Arsenal. The Inspector General's report said of the Arsenal Commandant: "His administration of its affairs has been characterized by zealous and unremitting personal supervision over all details of management involving the expenditure of government funds and supplies with a view to effecting all practical economies and securing maximum returns from all expenditures." In transmitting this report to Colonel King, The Assistant Secretary of War, Col. F. H. Payne, added his own commendation saying that the report "only confirms the impression that I received when I last visited you. This office has known that the procurement mission with which you have been entrusted has at all times been ably performed. The position that you have assumed in the community surrounding Rock Island is not the least important of the achievements of your long and successful administration of Rock Island Arsenal. The War Department has greatly benefited by having you hold so high a place in the esteem of your community."

Rock Island Arsenal, where Colonel King had spent twenty-two years of his nearly forty-three years of Army service, was the scene of a great tribute at his funeral on January 30th. Solemn funeral services of the Catholic Church were conducted in the auditorium at the arsenal and were attended by high dignitaries of the Church, officers and organizations of the Army and civic and patriotic groups of the Tri-Cities. Burial took place in the national cemetery on the island he loved so well. His grave overlooks the site of the new Moline Bridge, a project in which he was greatly interested.

ARMY ORDNANCE records its own sense of loss in the death of one of its most active supporters. It joins its condolences in the name of the entire membership of the Association in expressing to Colonel King's widow its heartfelt sympathy.

# Corps Artillery Weapons

## *Their Post-War Development and Present Status*

By Elmer C. Goebert*

THE subdivision of mobile artillery into the three general classes, namely, division, corps and army, establishes characteristics in each of the classes which make the design of weapons for each group distinctive. The types of weapons necessary and suitable in each class are controlled and limited directly by the missions assigned. It is therefore desirable before proceeding to state as clearly as possible the prescribed mission of the weapons of which this discussion treats.

The mission of corps artillery has been defined as "the protection of division artillery against enemy artillery." Further considering this mission, it consists of extensive harassing and interdiction fire along the corps front to a greater depth than fire from division artillery and the delivery of fire on strong points, railroad and supply facilities.

The Caliber Board in its report of May 5, 1919, selected two weapons for the corps group: a gun and a howitzer. It defined the ideal gun as a weapon 4.7 to 5-inch bore with a maximum range of 18,000 yards mounted on a carriage with a weight between 12,000 and 15,000 lbs.; 360° traverse and —5° to +80° elevation. The ideal howitzer was specified as a 155-mm. bore with a maximum range of 16,000 yards; 360° traverse and elevation between the limits of —5° and +65°; the weight limit was not specified but it is assumed that it should be commensurate with that for the gun, namely, between 12,000 and 15,000 lbs.

During the World War the corps gun used by the American Forces was the 4.7-inch gun, Model 1906. It had a maximum range of 8,860 yards, 15° elevation, 8° traverse and weighed 9,818 lbs. limbered and in traveling position. The carriages manufactured before the World War were equipped with steel-tired wheels (Fig. 1), while those constructed during the War had solid rubber-tired wheels (Fig. 2).

THE companion piece to the 4.7-inch gun was the 155-mm. howitzer (Schneider), models 1917 and 1918. The model of 1917 (Fig. 3) had a curved shield and was equipped with steel-tired wheels. It was manufactured by the French. The model of 1918 (Fig. 4) was the American-manufactured 155-mm. howtizer. It had a straight shield and was equipped with solid rubber-tired wheels. These howitzers had a maximum range of 12,400 yards; 42° elevation, 6° traverse and weighed 9,485 lbs. limbered and in traveling position.

For a clearer comparison there is tabulated below the principal characteristics of the war-time, and the Caliber Board's ideal specifications for the corps gun and howitzer.

GUN

| | Bore | Range | Elevation | Traverse | Weight Traveling |
|---|---|---|---|---|---|
| War type | 4.7" | 8,860 | +15° | 8° | 9,818 |
| Caliber board | 4.7"—5" | 18,000 | —5° to + 80° | 360° | 12,000—15,000 |

HOWITZER

| | Bore | Range | Elevation | Traverse | Weight Traveling |
|---|---|---|---|---|---|
| War type | 155 mm. | 12,400 | +42° | 6° | 9,485 |
| Caliber board | 155 mm. | 16,000 | —5° to + 65° | 360° | 12,000—15 000 |

A study of these comparative specifications definitely indicated that to approach the ideal for both these weapons the box-trail type carriage could not be considered and that at least the minimum weight limit would be required to meet the additional power necessary to reach the range specified and produce a carriage with satisfactory stability. Accordingly the Ordnance Department in 1919 initiated the studies of a carriage of the split-trail type to mount interchangeably a 4.7-inch gun and 155-mm. howitzer, ballistics of which approached as nearly as possible the ideal specified.

The pilot carriage was constructed and designated as the model 1920. Fig. 5 illustrates this carriage mounting the 4.7-inch gun, while Fig. 6 shows it mounting the 155-mm. howitzer.

With the gun mounted the carriage weighed 13,600 lbs. in firing position and 15,800 lbs. limbered and in traveling position. It had a maximum range of 20,050 yards, elevation 65° maximum and 60° traverse. Mounting the howitzer the unit weighed approximately the same as with the gun. It had a maximum range of 16,390 yards, elevation of 65° and traverse of 53°.

The carriage was, as previously mentioned, a split-trail type, was spring suspended in traveling position, the springs being by-passed for firing position by inserting a pin which locked the bottom carriage to the axle. The gun and howitzer were brought well forward on the top carriage to provide the high angle of elevation and as a result the center of gravity of the tipping parts to be elevated was a considerable distance in front of the trunnions. To compensate for this unbalanced load condition pneumatic equilibrators were designed for this mount, which as far as is known were the first of this type ever successfully applied to mobile carriages in the United States.

THE first tests of the carriage were conducted at the Rock Island Arsenal. With the 4.7-inch gun mounted it was given a road test and then fired. The 155-mm. howitzer was then mounted with its top carriage and the weapon fired. These firings developed defects and after further study it was decided to redesign the unit separating the gun and the howitzer into two distinct problems.

One of the principal reasons for this decision was that the howitzer stresses on the carriage required that the carriage be built with more strength and consequently more weight than would be warranted in a carriage suitable for mounting a 20,000 yard—4.7-inch gun.

The result of this decision as it effected the 4.7-inch gun

*Chief, Mobile Carriage Section, Artillery Division, Office of the Chief of Ordnance, Washington, D. C. Captain, Ordnance Department, U. S. Army.

# *The Corps Gun of Pre-World-War Days*

Fig. 1. 4.7-inch Gun Carriage, Model 1906, Pre-War Manufacture.

Fig. 2. 4.7-inch Gun Carriage, Model 1906, War Manufacture.

# *Howitzers of the World War Period*

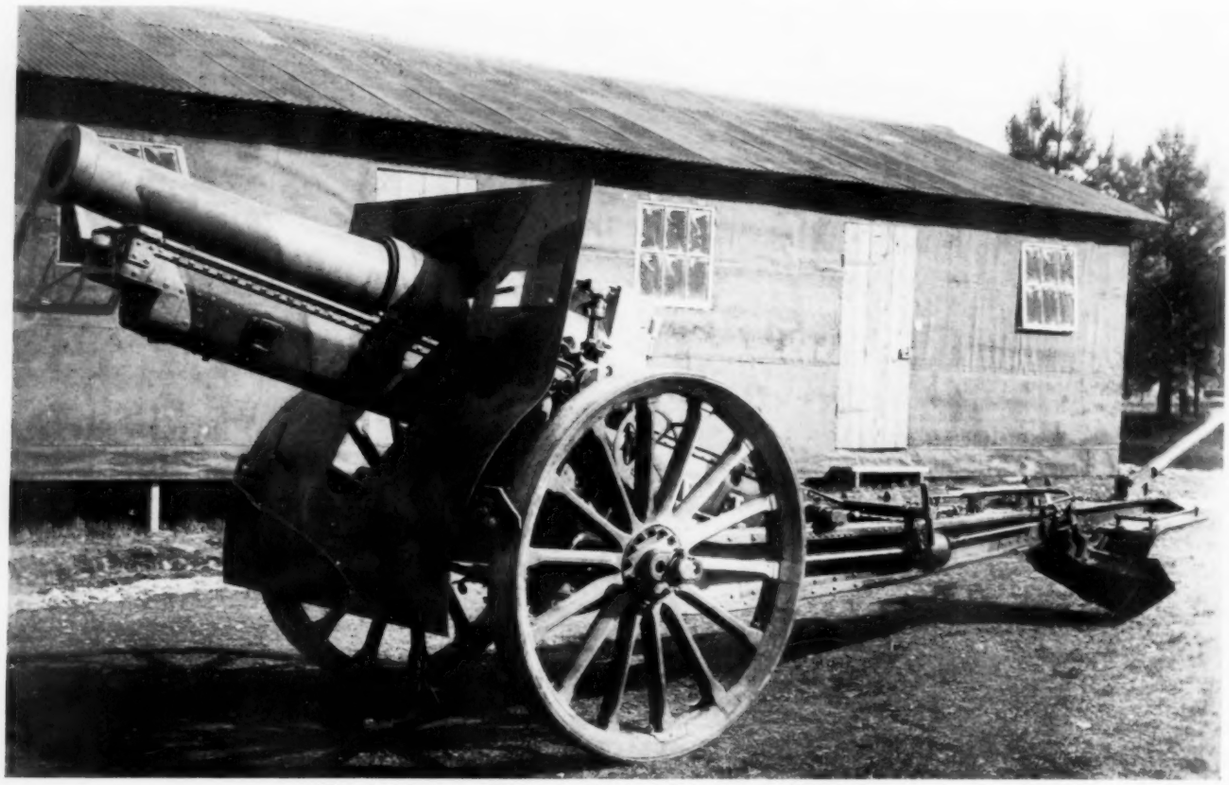

Fig. 3. 155-mm. Howitzer, Model 1917, French Manufacture.

Fig. 4. 155-mm. Howitzer, Model 1918, American Manufacture.

# *The Gun-Howitzer Carriage, Model 1920*

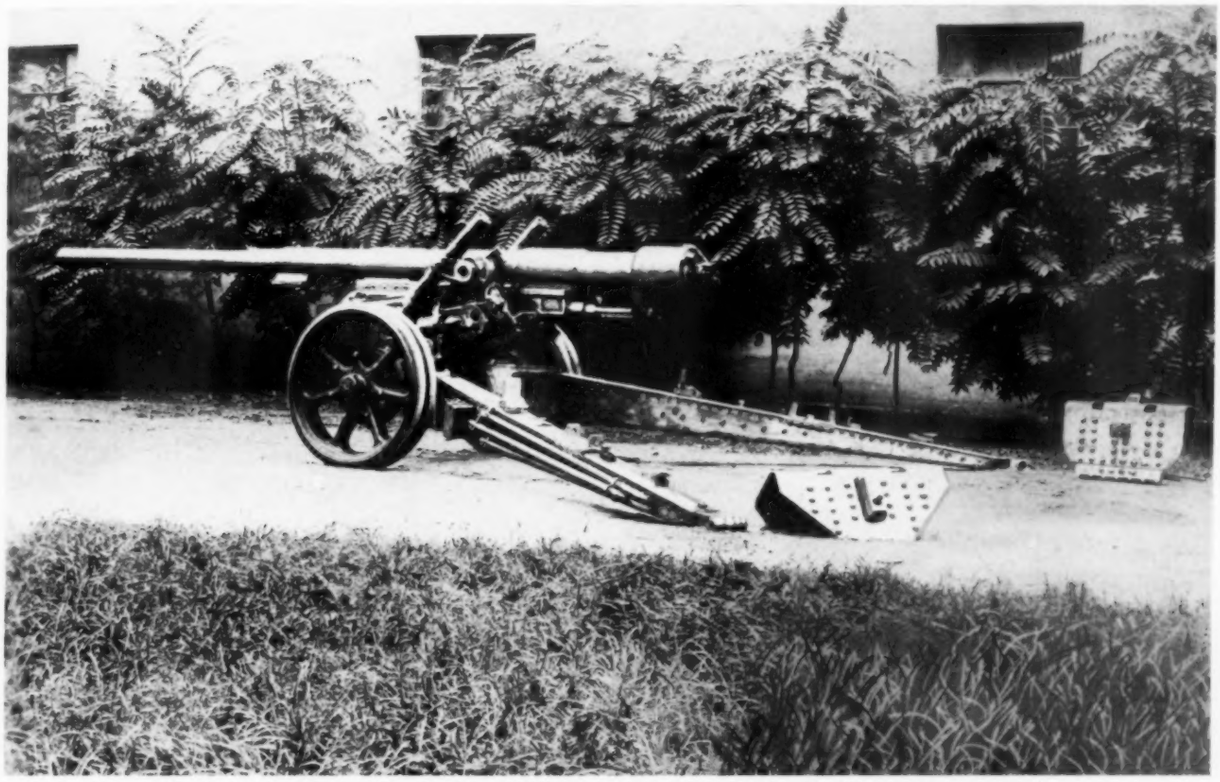

Fig. 5. 4.7-inch Gun—155-mm. Howitzer Carriage, Model 1920, Showing 4.7-inch Gun Mounted.

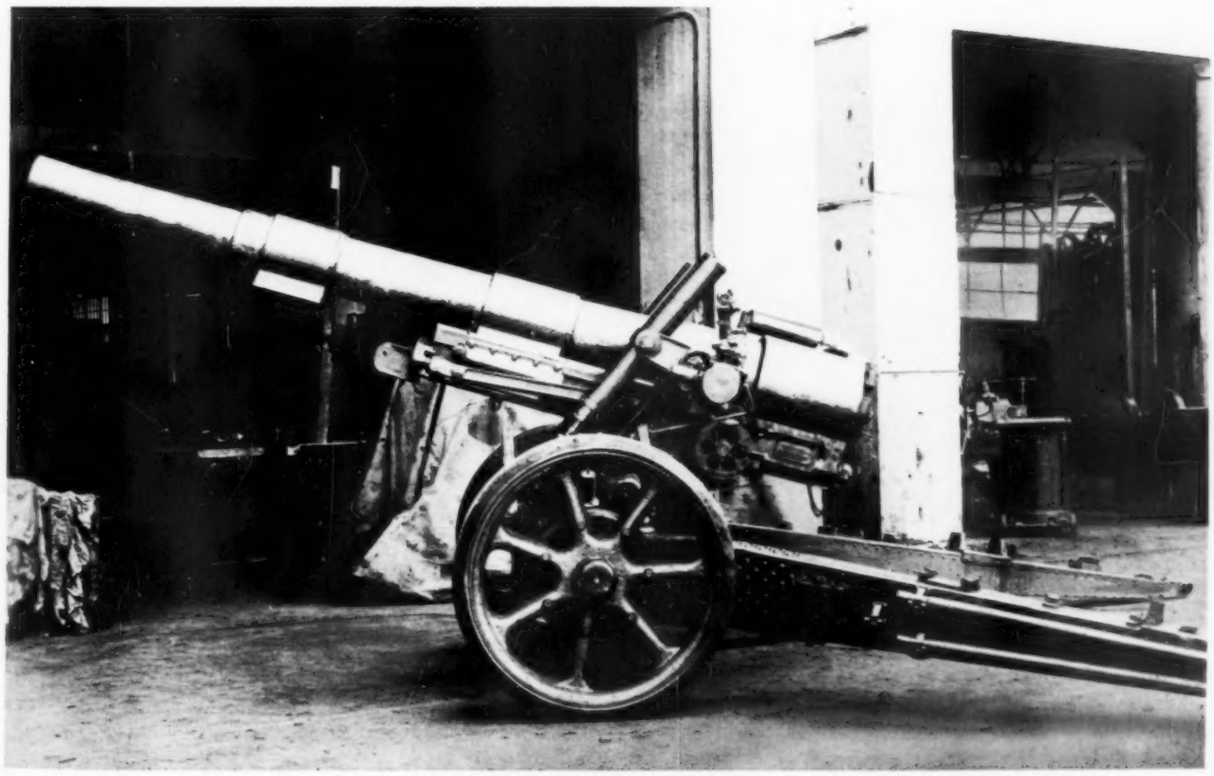

Fig. 6. 4.7-inch Gun—155-mm. Howitzer Carriage, Model 1920, Showing 155-mm. Howitzer Mounted.

# *Gun and Howitzer Carriages, 1921 and 1925*

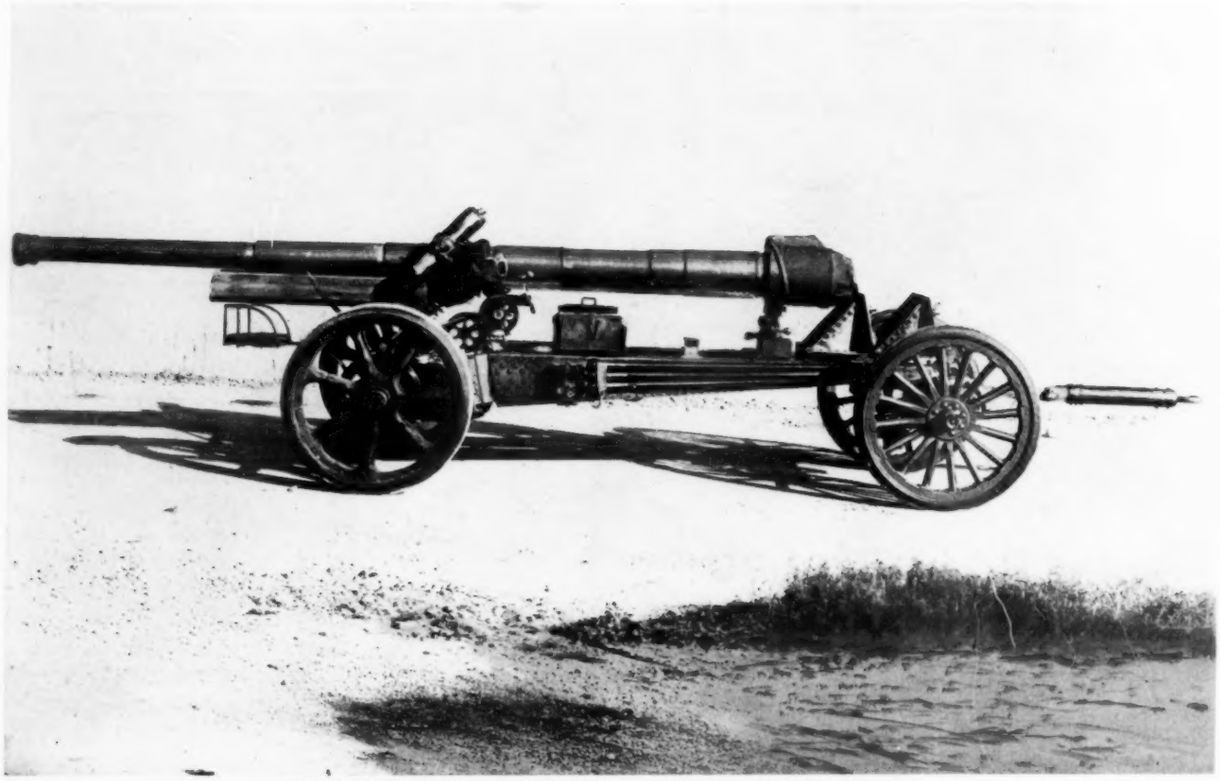

Fig. 7. 4.7-inch Gun Carriage, Model 1921E. in Traveling Position.

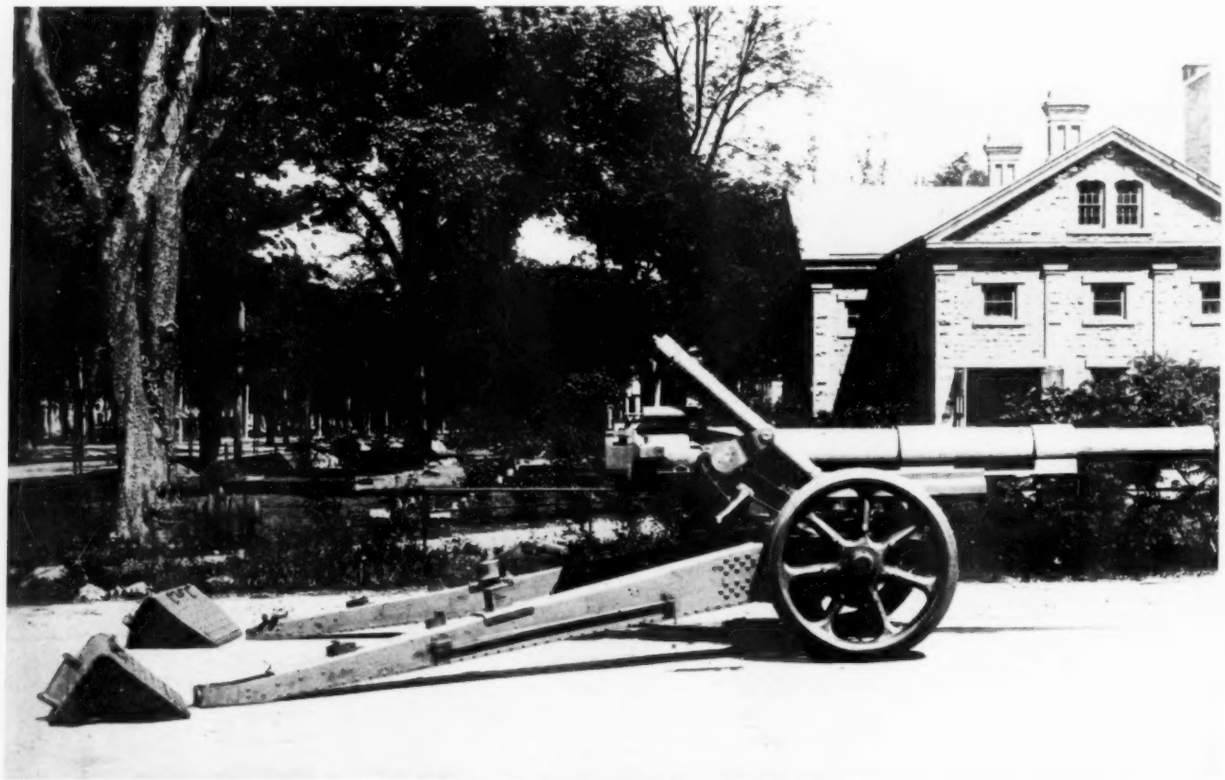

Fig. 8. 155-mm. Howitzer Carriage, Model 1925E.

# *The Present Design of 155-mm. Howitzer Carriage*

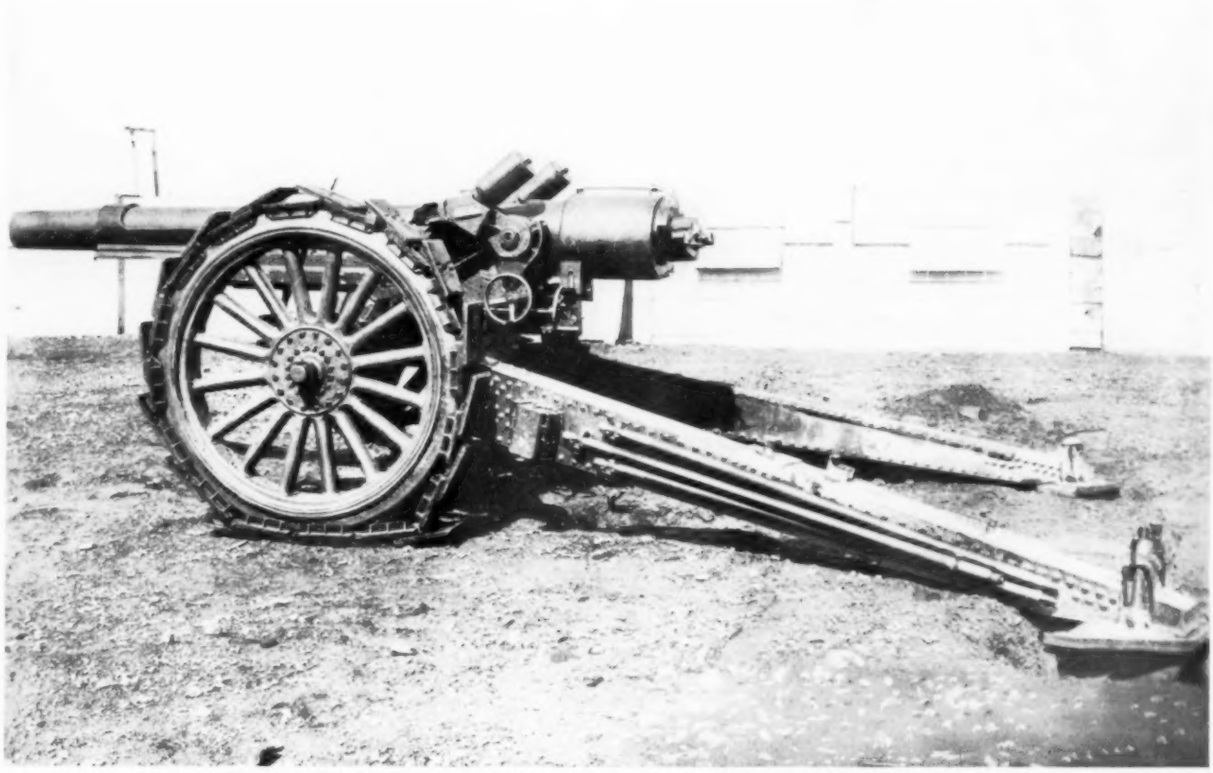

Fig. 9. 155-mm. Howitzer Carriage, Model T-1, 0° Elevation—Center Traverse.

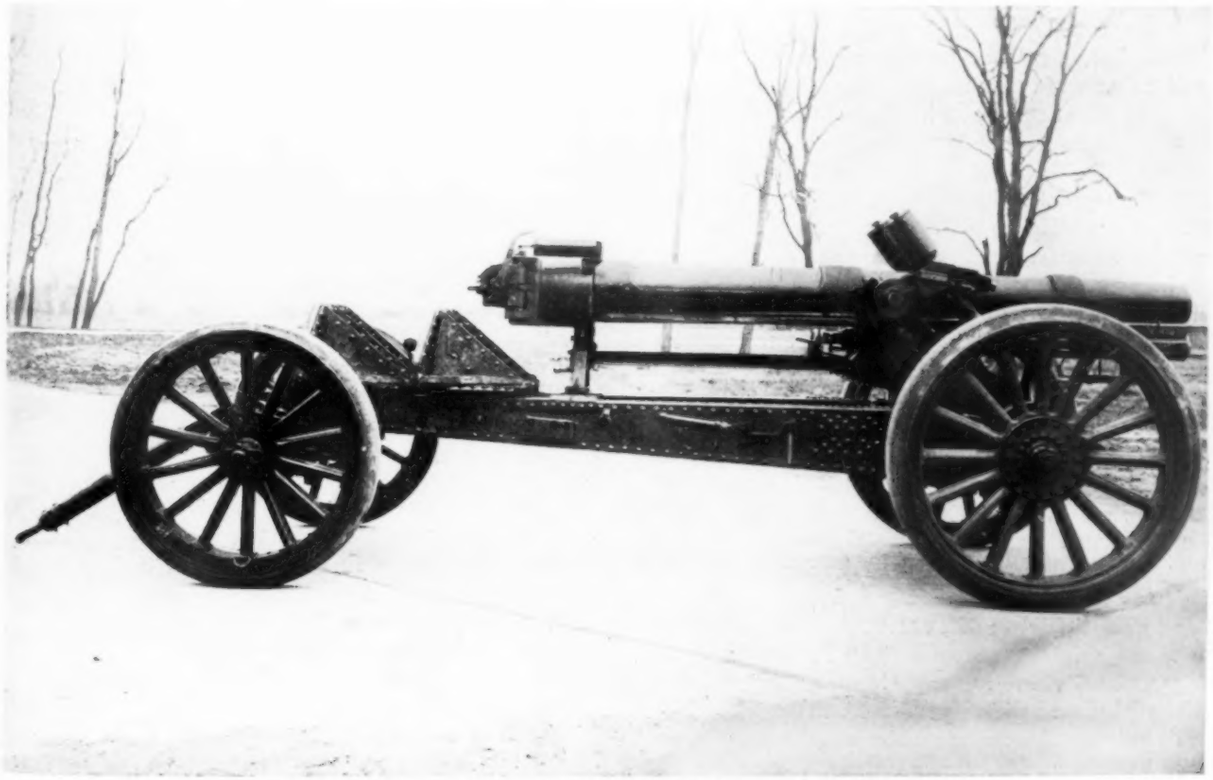

Fig. 10. 155-mm. Howitzer Carriage, Model T-1, Traveling Position.

project was the carriage model 1921, shown in Fig. 7. The carriage mounted the gun with maximum range of 20,050 yards, had 45° elevation, 60° traverse and weighed but 12,700 lbs. in traveling position. A comparison of this weight with the 15,800 lbs. required to produce the 1920 model shows clearly the advantage gained by separating the corps gun and corps howitzer problems.

With the 15,800 lbs. found necessary in the model 1920 carriage the gun was carried as a separate load on a transport wagon for sustained road travel. The transport wagon never has been a satisfactory vehicle and is a constant source of annoyance wherever it must be used. Due to reduction of the total weight of this carriage in the model of 1921 to 12,700 lbs. the gun was retracted for sustained travel and the transport wagon eliminated as an accessory to this unit.

The 4.7-inch carriage and gun, model 1921, were sent to Fort Bragg in February of 1925 for consideration by the Field Artillery Board. In March of 1926 a favorable report was received on this carriage and the mount was recommended for standardization. The final action toward standardization was never taken, however, since it was believed that with the development of other weapons progressing as they had the caliber 4.7-inch gun might not be a necessary unit, and pending final decision on this point the entire project was indefinitely suspended.

Should the 4.7-inch gun again become an active project it will no doubt be necessary to completely redesign the carriage for in the interim since it was built many new developments have been perfected in the art of gun carriage design and the requirement for speed in road transportation has been added to the specification of a satisfactory mobile artillery carriage.

EARLIER in this article it was brought out that the corps gun and howitzer were first studied as an interchangeable problem, namely, one carriage to mount either the gun or the howitzer. In the attempted solution exemplified by the model 1920 carriage tests with the howitzer mounted gave considerable trouble due to the persistent failure of the top carriage. In December of 1923 the two problems were definitely separated and a project inaugurated to produce a design of carriage to mount the 155-mm. howitzer. This conclusion came only after three years of careful study.

The 155-mm. howitzer mounted on the model 1920 carriage with the top carriage reinforced as best it could be was sent to the Field Artillery Board so that the problem of maneuverability could be studied and such recommendation made as would enable the Ordnance Department to embody in the new design the most desirable feature known at the time. This new design was designated as the model of 1925.

The design was completed and a full size wooden model built at Rock Island Arsenal. This model was shipped to the Ordnance Department in Washington for study. It is illustrated in Fig. 8. The general characteristics of the design are: maximum range 16,390 yards, maximum elevation 65°, total traverse 60°, estimated weight in firing position 12,892 lbs., estimated weight in traveling position 14,332. The unit was to be spring suspended mounted on solid rubber tires with a width of 8 inches, the wheels to be 60 inches in diameter and with a tread width of 70 inches. It had several new features among which were a quick return mechanism to facilitate loading for high-angle fire and a new type flatted pin which could be turned by a wrench through 90° to lock the bottom carriage to the axle and thus by-passing the spring suspension for firing.

The model was studied in every detail and as a result was abandoned and the model designated as the 155-mm. howitzer carriage T1 was designed and built. This carriage is shown in Figs. 9 and 10.

The general characteristics of the T1 howitzer are—maximum range 16,390 yards, maximum elevation 60°, total traverse 55°, weight in firing position 14,300 lbs., weight in traveling position 16,500 lbs. It is provided with wheel shoes which bring the total weight in traveling position to 18,400 lbs. It is spring mounted on wheels 60 inches in diameter equipped with solid rubber tires 8 inches wide and a tread width of 74 inches.

The center line of the bore at 0° elevation is 54 inches above the ground and with the relation of the rear face of the breech and trunnions and a 48-inch constant recoil requires a small pit to be dug for high angles of fire. It is equipped with pneumatic equilibrators with an adjustable element to compensate for the effect of changes of temperature on the force exerted by the mechanism.

The carriage is suspended on a leaf spring for resilience in travel. The spring is by-passed when going into firing position by rotating a flatted pin by means of a self-locking worm and work wheel mechanism operated by a ratchet wrench.

The bottom and top carriage of this mount were made of steel castings since at the time of their construction the art of welding had not sufficiently progressed to permit its use in these elements. The trails for a like reason are riveted box sections. A second one of these units designated as the 155-mm. howitzer carriage T1E1 embodying certain improvements, but constructed along the same general lines, has been built.

These units at the present time are undergoing tests by the Field Artillery Board and the Ordnance Department. It is doubtful, however, whether these units will be the weapons finally standardized for use by the Army. They were built for draft by tractors and are not suitable for towing by truck prime movers.

The highly efficient six-wheel, four-wheel drive commercial truck has demonstrated that for road mobility they will be a suitable prime mover and it is, therefore, highly desirable that the modern gun carriages be wheeled and bearinged to make them a suitable towed load for a truck.

To change the 155-mm. howitzer carriages T1 and T1E1 so that they will be satisfactory to tow at speeds of from 20 to 30 miles an hour would require major modifications and it therefore seems advisable at the same time to redesign the entire carriage taking advantage of welding and eliminating as much weight as practicable together with the necessity of a pit for high-angle fire.

Preliminary studies made by the writer indicate that by increasing the recoil from 48 to 54 inches at zero degrees and gradually shortening to 27 inches at maximum elevation a carriage could be built with the center of the bore 44 inches from the ground which would permit satisfactory stability within the limits of 15,000 lbs. in traveling position. In this design could be incorporated every feature to give it satisfactory road mobility behind trucks and the use of the modern welding to simplify manufacture of the carriage.

# Army Ordnance During 1931

## *Extracts From the Annual Report of the Chief of Ordnance*

**By Major General Samuel Hof***

DURING the past year the Department has been operating under the decentralized system for war planning established in the fiscal year 1929. The system has proven satisfactory, and no change has been made in it. During the year one special plan has been completed, two special plans have been revised, and the Ordnance Plan for the Test Mobilization and Plan of Concentration was prepared.

Plans of the Manufacturing Service for war-time manufacture at arsenals and war-time procurement from industry have progressed satisfactorily under the known established policies. A number of Descriptions of Manufacture have been completed, but a policy of finishing lists of operations and bill of material, together with summary of machine tool requirements, has been instituted for all important items rather than attempting to make more complete descriptions of manufacture, including fixtures and tool drawings, etc., for one item at a time. From reports based on these preliminary manufacturing data, District Offices are able to furnish information to the Ordnance Office which can be used in Special or Color Plans, as well as the General Mobilization Plan, and will be immediately useful in procurement in any war for which a plan may not have been prepared. Work on such reports has been started for shell forgings, shell machining and artillery cartridge cases, as the items presenting the most difficult procurement problems. Satisfactory planning for procurement of shell forgings has been made possible by amendment of the so-called "Steel Plan" by the Office of The Assistant Secretary of War which will allow direct contact between Ordnance Districts and possible producers of these forgings.

As a result of a new form for requisition of allocation of facilities for production, recommended by the Ordnance Department and adopted by the Office of The Assistant Secretary of War, a complete re-check of such allocations has been completed, resulting in a number of cancellations of unsuitable companies, and assembly of accurate information in the present organization of industry, which has changed materially due to numerous mergers.

A detailed study of the problem of ammunition loading has been instituted. As one phase of this study, all of the possible localities for loading plants are being investigated and reported upon by District Offices to determine the best ones.

It has proven necessary to assemble total War Department requirements on certain major industries. During the present year a working agreement has been reached between the Ordnance Department, Quartermaster Corps and Air Corps which will shortly enable presentation to the automobile industry of the total War Department requirements upon it. Ordnance Department procurement plans for the automobile industry—an extremely important phase of planning—have not progressed satisfactorily to date, lacking this.

*Chief of Ordnance, U. S. Army.

Special mention of the able direction of each of the fourteen District Offices by an industrial leader who continues to give largely of his time to this work through purely patriotic motives, is warranted. The Ordnance District Offices have proved to be useful establishments beyond their primary function of contact with industry in war planning, and they furnish the most satisfactory means of procuring and training Ordnance Reserve Officers of the Branch Assignment Group. They have proved useful in locating new sources for current procurement, and in assisting arsenals in inspection functions. Their contact with industry has resulted in useful recommendations for changes in design to facilitate production, and the officers on this duty are obtaining most valuable education in business organization, operations and methods.

ONE of the chief ammunition maintenance problems of the year was that of culling caliber .30 ball ammunition of World War manufacture for issue to the service. Owing to season cracking, corrosion and other visual defects, about 20 per cent of the existing stocks are unsuitable for issue. Before issues are made the defective rounds are culled out. This is a large task each year, involving the close examination of every round issued to the civilian components of the Army and of lots issued to the Regular Army when the number of defective cartridges is greater than 20 per cent. When the number of defective cartridges in a given lot is less than 20 per cent, the lot is issued to Regular Army units without culling, and the troops are expected to eliminate the defective cartridges.

Owing to the rapid decrease of caliber .30 ammunition of World War manufacture by deterioration and expenditure, with the probability that there would not be a sufficient quantity of Grade 2R (for use in rifles) to meet target practice for the fiscal year, a study of existing stocks was made which resulted in a complete regrading of caliber .30 ammunition. To augment the stock of grade 2R ammunition, Grade 1 ammunition heretofore reserved as having a longer expectation of shelf life, was regraded into usable grades for issue, and the functioning limits for accuracy of grade 2R were raised from a mean radius of not more than 7½ inches at 600 yards range to a mean radius of not more than 8 inches at the same range. By these measures the stock of ammunition suitable for rifle was increased so that target practice in the continental United States can be supplied for about two years.

In accordance with the approved program for the renovation or rebuilding of ammunition which has deteriorated but can still be reclaimed at small cost by the replacement of deteriorated components, the Ordnance Department has not only operated the existing renovation plants for work on the 75-mm. H. E. shell, but has created two additional plants for this caliber, and one for the 155-mm. shell. Of the two plants created for 75-mm. ammunition, one has

been established at Nansemond Ordnance Depot for shell renovation with an economical capacity of about 1,000 rounds per day, and the other at Curtis Bay Ordnance Depot, for shrapnel renovation, with a capacity of about 1,200 per day. Both plants are in full production at the present time. The 155-mm. plant is in process of creation at Savanna Ordnance Depot, and will attain its rated capacity of 500 shells or more per day early in the fiscal year 1932.

The shell plants at Charleston and Delaware Ordnance depots have operated continuously throughout the fiscal year, but the shell plants at the Raritan Ordnance Depot and in the Hawaiian Department were closed for a part of the year, pending the accumulation of further stocks of ammunition requiring renovation.

There are thus in existence five 75-mm. shell renovation plants (Hawaii, Charleston, Nansemond, Delaware, and Raritan), one 75-mm. shrapnel (Curtis Bay), and one 155-mm. shell plant (Savanna). The Delaware plant is equipped to renovate shrapnel also, and has executed one shrapnel order in the past year, in addition to its primary shell work. The possible use of these existing facilities as loading plants in time of war is being studied. As loading plants only, with all components furnished, the daily capacity would be much greater than the present daily output of renovated shell. It is hoped that it will be possible to plan a daily output from these plants that will be a long step toward the early supply of newly loaded ammunition of these two vital calibers in the first few months of any future emergency.

The actual output of renovated 75-mm. ammunition in the past fiscal year was: Hawaii, 74,972 shell; Charleston, 168,046 shell; Raritan, 30,972 shell; Nansemond, 79,307 shell; Delaware, 138,992 shell and 47,603 shrapnel; Curtis Bay, 69,383 shrapnel. The total output of 492,289 rounds of shell and 116,986 rounds of shrapnel has been accomplished at a cost of about $2.50 for each shell and about $4.00 for each shrapnel.

UNDER the provisions of the Act of June 1, 1926, The Secretary of War is authorized to exchange deteriorated or unserviceable ammunition for ammunition or components thereof in condition for immediate use. The Ordnance Department has taken full advantage of this authority of law in the past year in disposing of deteriorated smokeless powder and other components of ammunition in exchange for new powder for the 75-mm. gun. Approximately 203,000 pounds of new powder have been thus obtained. The stocks so obtained have been used in replacing deteriorated powder charges during the renovation of 75-mm. ammunition.

The World War stocks of smokeless powder are becoming an increasing care, because of deterioration, and it has been the policy of the Department to dispose of all powder on the basis of surveillance tests well in advance of any chance of spontaneous combustion. It is fortunate that commercial uses in the lacquer and other industries have been found to serve as an outlet for the disposal of this deteriorated powder on advantageous terms. Otherwise it would have been necessary to destroy large stocks which it would have been imprudent to keep any longer. The exchange ratios obtained have reflected the changes in the present commodity markets, with much better ratios offered at the beginning of the fiscal year than at its end.

Smokeless powder of the flashless nonhygroscopic type has now been approved for use in all calibers of weapons from 37-mm. to 16-inch, inclusive, although development work is still progressing to determine the most suitable granulation for some of the calibers and for the purpose of trying out various chemical compositions. For calibers of 6-inch to 16-inch, as well as for the 3-inch antiaircraft guns, this powder is not consistently flashless and is designated as "nonhygroscopic" powder. Efforts to improve powder to meet the flashless requirements are being continued. To date, the solution of this problem in the larger calibers results in an objectionable amount of smoke. Accordingly, service tests are being conducted using a packet, which can be added to the nonhygroscopic charge at will, to render the charge flashless in night firings, when the smoke resulting from the increment will not be objectionable. It is hoped that this packet will be only a temporary solution, and that further development may result in obtaining flashlessness without excessive smoke.

THE development of semiautomatic shoulder rifles has continued during the year, and there have been produced for test by the Infantry and Cavalry a total of 20 caliber .276, Model T3 (Garand) rifles which are now undergoing test by the using services in comparison with 20 Pedersen, caliber .276, semiautomatic rifles, referred to in my last annual report. The White rifle, referred to in my previous annual report, was tested at Aberdeen Proving Ground during the year, and showed considerable promise. Additional tests of this rifle are projected. Tests have been conducted of an improved model caliber .276 semiautomatic rifle, submitted by Mr. J. D. Pedersen, which includes a breech mechanism functioning without the use of lubricated ammunition. A rifle on the general design of the Garand type in caliber .30 is in process of development and should be ready for test at the Aberdeen Proving Ground in the near future.

Studies and tests have been made in connection with the development of an air-cooled type machine gun. The caliber may depend upon the final recommendation of the Board on Semiautomatic Rifles. Indications are that a reasonably efficient air-cooled weapon may be developed within the weight limits which have been tentatively set by the using arms.

Approximately 100 Browning tank machine guns, caliber .30, M 1919, have been modified to provide suitable sights, carrying straps, light tripod mount, etc., to make them suitable for use as ground guns. These weapons are known as "Browning Machine Gun, caliber .30, M 1919, E1." They have been supplied to the Cavalry for extended service test, with a view to development of tactical doctrine based on additional fire power. A project is under way to supply the Infantry with a number of similarly modified weapons for this purpose.

The pilot 155-mm. gun—8-inch howitzer carriage T2, referred to in my report for 1930, was completed at Rock Island Arsenal and transferred to Aberdeen Proving Ground, where it is undergoing test. At present, it is equipped with the 8-inch howitzer, M 1920, only, as sufficient funds to alter the 155-mm. gun, M 1920, to suit the carriage were not available. Plans are being made to alter this gun as soon as funds become available during the fiscal year 1932. Preliminary firing tests indicate that this unit is satisfactory

as a firing unit. In road tests this matériel has been transported at speeds as great as 45 miles per hour, this being made possible by the use of pneumatic tires and spring supports provided in the carriage and limber. The units will be transferred to Fort Bragg as soon as practicable for tests as an 8-inch howitzer carriage.

MECHANIZATION was attempted seriously for the first time in the summer of 1928, using available vehicles for practically the entire equipment. The force assembled this year, while using a considerable amount of existing matériel, is also being equipped to the maximum extent practicable with new vehicles designed for the purpose, as well as by some modifications to existing vehicles better to adapt them to use by such a force. For this purpose a special fund appropriated by the Congress has been used.

Improvements in design have permitted an increase in the armor protection of mechanized vehicles without increasing the total weight of the vehicle, as well as providing better armament and gun mountings. Applying the lesson learned from the earlier experiments in mechanization, every effort has been made to secure adequate speed, high relativity, the maximum of fire power and as much cross-country mobility as is consistent with the type of design employed.

The new and modified vehicles developed for mechanization include four types of armored cars ranging from very light 2-wheel drive cars and light 4-wheel drive cars produced by the Quartermaster Corps in coöperation with the Ordnance Department, to 2-wheel drive medium cars and 6-wheel, 4-wheel-drive medium cars developed by the Ordnance Department.

To provide the necessary fast tanks, the Ordnance designs of T1E1 and T1E2 light tanks, which were three years old, were thoroughly overhauled, in some cases re-engined with new engines, equipped with improved suspension and in one instance complete radio equipment developed by the Signal Corps, was added; also six of the 6-ton tanks of war-time production were re-engined with 80 horse-power air-cooled engines. The cargo carriers on the same chassis as the T1E1 tank were overhauled. One was converted to a 4.2-inch (chemical) mortar motor carriage; one to an artillery motor reel for laying telephone wire; and the remaining one was supplied for use as an artillery caisson. The success of mechanized equipment depends on high speed tracklaying vehicles. Vehicles of such characteristics are not available commercially, and all mechanized vehicles of this type have been developed specially by the Department.

IMPROVEMENTS in existing armored cars consisted of modifications of the bodies and gun mounts, in accordance with request made by the Chief of Cavalry, of the four armored cars manufactured in 1928 on La Salle chassis. The principal modification was the reduction of height and the addition of turrets and gun mounts. This modification was of such a character that it could be handled by Ordnance repair shops. These cars are still in service after about 20,000 miles, and continue to give very satisfactory performance.

The Ordnance Department coöperated with the Quartermaster Corps in the construction of five light and six medium armored cars by providing the necessary turrets, gun mounts and guns.

To provide armored cars of modern design, two cars of the 6-wheel, 4-wheel drive, type are being developed. In the design of these cars the structural strength of the armor-plate body is being employed in place of that of the chassis frame which has been eliminated to enable the weight thus saved to be put in armor protection.

WORK on tanks during the year has included completion of details of tests of the T1E1 and T1E2 light tanks. These vehicles have been overhauled, and one has been converted to a full spring suspension type, another to a combination of spring and link suspension.

Six 6-ton tanks M 1917 were modified to give higher tactical speed by slightly lengthening the engine compartment and installing an 80-h. p. passenger car type, air-cooled engine. This limited number was modified as an expedient to provide somewhat higher speed in this type for tactical tests. This modification is not considered as representing a new technical development, nor has it been proved that the modification is acceptable from a design viewpoint.

The medium tank (T2), which was completed this year, is the result of much research and development work with a view to securing a medium tank of proper characteristics to meet the specifications laid down by the using service and still come within the 15-ton weight limit imposed by the Secretary of War. Former medium tanks built to meet these specifications weighed in the neighborhood of 23-tons. This new tank meets all of the specifications and provides more fire power than was formerly thought possible in a tank of its weight. It is well armored, has a very elastic and smooth riding suspension, and handles better than any of its type previously tested. The principal armament is a 1.85-inch semiautomatic cannon combined with a caliber .50 machine gun, and the secondary armament is a combined 37-mm. gun and caliber .30 machine gun. If desired, a semiautomatic 37-mm. gun of higher power may be used in place of the gun now mounted. The 1.85-inch semiautomatic cannon was developed for this tank. It has given entire satisfaction in test except that the velocity is somewhat below that desired. A new tube to give higher muzzle velocity is being developed. This tank has been run 1,000 miles and is still in good condition mechanically.

The Christie convertible type tank (medium T3) has been through an acceptance test and a number of demonstrations. A contract was signed in June 1930 for the procurement of one tank and a complete set of drawings. This tank was delivered for test in January 1931. After the tank had finally completed most of the acceptance test under the supervision of a special War Department Board, the Ordnance Department offered to accept the tank and drawings at a nominal reduction in price, due to its failure to fully meet the contract requirements. Mr. Christie, however, failed to deliver the tank and drawings in a reasonable time, and the tank was therefore necessarily rejected. Procurement specifications for this type were then approved, advertisements for the procurement of a number in the open market for service test were issued, and in June a contract was made with the U. S. Wheel Track Laver Corporation for the manufacture of seven such convertible tanks from funds appropriated by the Congress for that sole purpose.

# Naval Ordnance During 1931

## *Extracts from the Annual Report of the Chief of Bureau*

**By Rear Admiral E. B. Larimer***

THERE are 23 officers on duty in the bureau. The number of civilian employees in the combined technical, clerical, and custodial forces is 66. The bureau's inspection force in the field consists of 8 officers and 33 civilians. Inspections of ordnance material are also performed by inspectors of naval material and inspectors of naval aircraft in the various inspection districts.

Funds were appropriated and allotted for the fiscal year 1931, as follows:

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| Act of June 11, 1930: | |
| Ordnance and ordnance stores | $11,669,400 |
| Purchase and manufacture of smokeless powder | 1,000,000 |
| Torpedoes and appliances | 450,000 |
| Civilian employees of the bureau | 160,360 |
| Increase of the Navy, armor, armament, and ammunition | 10,600,000 |
| Act of March 4, 1931: | |
| Civilian employees of the bureau | 2,035 |
| Allotments from appropriations under the Secretary of the Navy: | |
| Major alterations, naval vessels— | |
| *Pennsylvania* and *Arizona* | 2,160,800 |
| *New Mexico, Mississippi,* and *Idaho* | 4,124,000 |
| Contingent expenses, Navy Department | 2,800 |
| Printing and binding, Navy Department | 14,000 |
| Labor-saving devices | 1,550 |
| Total | $30,184,945 |

The desire of the bureau is to reduce patent controversies, if possible, by adjusting differences between the bureau, the inventor, and owners of patents. The various sections of the bureau are constantly informed when new patents are issued in which they may be interested. This information should help to prevent infringement on new patents.

The bureau expended $3,335 by authority of the beneficial suggestion act to employees who made beneficial suggestions or inventions of unusual value.

The method of obtaining patent protection at present is as follows: The bureau sends the details of an invention to the Judge Advocate General where preliminary searches are made and the specifications and claims framed. The Judge Advocate General then requests the bureau to prepare the patent drawings as indicated. The drawings are prepared at the Naval Gun Factory under the bureau's order. When all is finally prepared, the Judge Advocate General's office files an application with the Patent Office and thereafter prosecutes the case to final issue. The filing date in the Patent Office is important but more important still is the recording of the date of the conception of the invention. This date should be recorded by drawing a rough sketch of the invention when it is so far completed that it discloses the general plan of accomplishing its purpose. The sketch should be dated and signed by the inventor and witnessed by three persons who acknowledge that this invention was disclosed to them and that they understood it.

Work on 8-inch and 5-inch batteries for new construction is progressing favorably. Five-inch batteries for the *New Mexico* and *Mississippi* have been ordered. One 3-inch 50-caliber antiaircraft gun and mount has been converted to wet type and has been shipped for installation on the *Bass*. Five more are under process of conversion for the *Barracuda*, the *Bonita*, the *Cachalot*, the *Cuttlefish*, and one for spare. Two 4-inch 50-caliber guns and mounts are being converted to wet type, one for installation on the *Dolphin* and one for spare. Guns for regunning the 16-inch and 14-inch batteries of the *West Virginia* and *New York* have been shipped. Routine regunning of 4-inch 50-caliber batteries of destroyers and of submarines is continuing.

After competitive bidding contracts were awarded to commercial firms for 16-inch and 14-inch liner forgings and for 5-inch barrel forgings for use in relining guns during the fiscal year 1932. During the year, twenty 8-inch and forty-eight 5-inch guns were completed at the Naval Gun Factory. In addition, the Naval Gun Factory lined, relined or modified thirty-three 5-inch, two 8-inch, seven 14-inch, and nine 16-inch guns. Delivery has been completed of all turret mount material required for the modernization of the *Arizona* and *Pennsylvania*. Modernization plans for turrets of the *New Mexico, Mississippi,* and *Idaho* are well under way, and work has commenced on turret material for the first two ships of this group.

Gun-elevating motors have been replaced in all turrets of the *Texas*, and the 2-gun turrets of the *Nevada* and *Oklahoma*. Replacement of similar motors in turrets of the *New York* will be undertaken at the next overhaul period of that vessel. Eight-inch triple mounts for the *Portland* and *Indianapolis* have been completed and shipped. Mounts for the remaining cruisers of this group are in process of manufacture. Thirty-six guns and mounts of various calibers, ranging from 1-pounder to 5-inch, have been issued to the Coast Guard for installation on vessels under construction. Available ordnance material has been issued from time to time to the Naval Reserve.

Development of a single antiaircraft mount for the .50-caliber machine gun has been completed, and an order for these mounts has been placed with the Naval Gun Factory. Two 1.1-inch machine guns have been built and proved. Modifications of the original guns are being made to increase the reliability and rapidity of fire.

CONTRACTS for armor for the *New Orleans, Astoria,* and *Minneapolis* were awarded to various steel companies. The specifications for light armor were revised as a result of experiments conducted by the bureau. Tests were made in coöperation with the Bureau of Construction and Repair of bullet-proof steel and armor gratings in connection with the revision of specifications for these materials.

Contracts for 4-inch and 3-inch illuminating, 5-inch antiaircraft common, and 6-inch target projectiles were placed with commercial manufacturing firms during the past year.

*Chief of the Bureau of Ordnance, Navy Department.

The naval powder factory has operated continuously throughout the year with the following output: New powder, 1,911,728 pounds; reworked powder, 304,935 pounds. In addition, 248,000 pounds of smokeless powder were procured from a commercial source. The custom of obtaining all small-arms ammunition from the Army has been continued.

The expenditure of smokeless powder was approximately a half million pounds less than the amount purchased and manufactured, but of the powders expended a considerable amount was drawn from obsolete granulations. Withdrawals from service of powders showing a loss of stability has continued at a somewhat accelerated rate. Reworking old powders, blending powders, and reassignments of obsolete powders to active calibers have been continued with the resultant savings.

Restowage of ammunition at depots and stations to conform to the requirements of House Document No. 199 has progressed continuously throughout the year. The naval ammunition depot at Hawthorne, Nev., was placed in commission early in the year, and all high explosives at ammunition depots in the United States have been shipped to Hawthorne with the exception of some bulk TNT at Hingham which will be moved on the next trip of the *Nitro*. The remaining capacity at Hawthorne will be filled from Yorktown.

The Bureau of Yards and Docks has awarded a contract for the construction of the new depot in Hawaii. Work has been deferred on the new depot in the Philippines. Testing equipment has been furnished the depots to prevent the issue of cartridge cases likely to cause jams.

THE modernized fire-control systems of the *Arizona* and *Pennsylvania* have been installed and have passed satisfactory shipboard test. The main battery and antiaircraft fire-control systems of the *Northampton, Louisville, Houston, Chester, Chicago,* and *Augusta* have been installed and have passed satisfactory shipboard tests.

Work has progressed satisfactorily on the fire-control systems of the *New Orleans, Astoria, Minneapolis, Portland,* and *Indianapolis*. Certain instruments have been completed and delivered, but, in general, the systems are in the process of manufacture. The contract for the antiaircraft fire-control system for the *Minneapolis* has not been let. Contracts have been let for the modernized fire-control systems, main and secondary batteries, for the *New Mexico, Mississippi,* and *Idaho*. Fire-control instruments have been removed from the *New Mexico* and *Mississippi* preparatory to modernization. The new range keeper, Mark VII, was installed on the secondary batteries of the *Pennsylvania* and *Arizona*, and on the main batteries of heavy cruisers 26 to 31, inclusive. Similar range keepers will be installed on the *New Mexico, Mississippi, Idaho,* and heavy cruisers 32 to 36, inclusive.

Improvement in bombing results has continued with the increased use of aircraft and training of bombers. Improvement in bomb sights has continued. With the delivery of the new type gun cameras during the fiscal year 1932 it is expected that the shortage in gun cameras will be overcome.

The bureau is continuing the development of aircraft machine-gun mounts suitable for the rear cockpit of observation-type airplanes. Aircraft manufacturers have continued in their efforts to help develop this mount in conjunction with bureau designs and have submitted many new ideas, some of which upon actual service test have demonstrated their practicability.

In continuing the study of bomb rack design throughout the year, an attempt has been made to inclose more and more of the bomb rack within the fuselage. This results in a decrease in the drag on the aircraft and affords more protection to the bomb rack. Aircraft targets which can be towed at high speeds satisfactorily have been developed and are being issued to the service.

A sufficient number of Mark VI catapults equipped with blast reducers has been provided. All Mark IV-1 turret-type catapults are being equipped with blast reducers as the availability of the various battleships at the navy yards permits. The work of manufacturing catapult guns, assembling these guns and testing the assemblies is continuing. In conjunction with the Bureau of Aeronautics, the policy of requiring aircraft manufacturers to install the more or less fixed items of aviation ordnance equipment, that is, items not readily detachable from the airplanes, has continued. Results have been extremely satisfactory and service use has shown that the policy should be continued.

Design work in the bureau, as in previous years, has been chiefly directed toward the improvement and completion of ordnance designs for new construction and for modernization of older ships. Type plans of the 8-inch guns and mounts for the *Tuscaloosa* and *San Francisco* have been completed and design of the ordnance installation and equipment for other construction authorized is under way. A number of studies have been made, or are now in progress, involving novel features of ordnance design. This important work is seriously handicapped, however, by the very limited design force which the bureau is allowed. This force is scarcely sufficient to keep pace with current work; consequently but little time can be devoted to novel design, or to the solution of problems, other than those of immediate urgency that are now before the bureau for consideration.

THE experimental, research, and development work conducted by the bureau has been as extensive and as active as possible with available funds. Most of this work was done in plants under control of the bureau. The advice and assistance of other governmental agencies was utilized if available. Contracts were let in limited number with commercial firms, as required by special developments.

Close liaison has been maintained with the technical staff of the Army Ordnance Department and the Chemical Warfare Service in connection with the experimental developments of both services. The various projects handled during the year had to do with improvements in projectiles, ballistics, projectile and bomb fuzes, aircraft flares and signals, torpedoes, smokes and smoke-projecting apparatus, bombs for practice work, optical instruments, tracers, pyrotechnics and explosives.

THE powder factory has operated continuously during the year at an average output of 7,578 pounds per day. The experimental and special work in the chemical laboratory has included surveillance of various explosives, analysis of explosives, test of illuminating mixtures, reclamation of TNT, and some experimentation with fulminate of mercury.

The naval proving ground fired a total of 8,688 rounds of all calibers from caliber .30 machine guns to 16-inch 45-caliber guns. An aviation unit forms an integral part of the naval proving ground organization. During the past year the total flying time for the unit was 683.95 hours (668 flights). There were two forced landings during the course of the year but no injuries to personnel. These flights were made in conjunction with acceptance tests of aviation ordnance material, altitude flights to determine atmospheric conditions, experimental work in connection with aviation ordnance, and routine tests and transportation flights.

DUE to the completion of work in hand and not sufficient new work started, it has been necessary to further reduce the force of the Naval Gun Factory. The total force is less, by 576 employees of various ratings, than it was at the ending of the previous fiscal year. It is hoped that sufficient new work may soon be put in production which may prevent any further material reductions in the working forces of the Naval Gun Factory. The work load is being carefully anticipated, as far as practicable, to assure a steady flow of work through the shops in order that discharges may be prevented or minimized as much as possible.

Due to the peculiar needs of the Naval Gun Factory, with its diverse activities requiring a high degree of skill and versatility, it has been difficult to secure the desired type of mechanic in sufficient numbers. The trend of the times toward mass production has tended to create specialists in branches of the various trades rather than mechanics skilled in all components. The apprentice system as now practiced in the Naval Gun Factory is an outgrowth of this condition. During the past few years, through the close coöperation of shops and schools, it has been possible to elevate the educational standards of apprentices. In the shops, by systematic attention, interest and example, the new apprentice rapidly becomes an asset. Numerous instances may be cited of ex-apprentices of the Naval Gun Factory holding responsible positions both outside and within the yard such as master mechanics, quartermen, leadingmen, draftsmen, planners-estimators, etc. It is thus evident that a self-sustaining source of labor of more desirable quality than usually obtainable elsewhere has been developed and has established a nucleus of potential leaders familiar with the plant, specifically trained in its methods, aims and needs, and capable of carrying on in times of rapid expansion such as have occurred in the past.

Design, experimentation, manufacture, and test of ordnance material have progressed satisfactorily. Improvements in machinery have been provided for increased production at reduced costs.

THE naval ordnance plant, Baldwin, Long Island, was put on a four-day-week basis on April 1, 1931, for a period of six months. This policy prevented the discharge of a number of employees. At the end of the six months' period, a report will be made as to the desirability of continuing or discontinuing the four-day week. Production included a total of 16,673 illuminating projectiles. Experimental work in connection with improving the flight characteristics of illuminating projectiles and giving an improved type of suspension for the star was continued throughout the year.

The naval ordnance plant at South Charleston continued in an inactive status. The policy of maintenance was modified on September 20, 1930, to include maintenance of only the officers quarters and grounds, the houses of the community, and the upkeep of the roads. Transfer of equipment and supplies to other Government activities was authorized on the same date and shipment of materials commenced on October 1, 1930. Eighty-six carloads were shipped by July 1, 1931.

THE naval torpedo station, Newport, R. I., has continued the manufacture and modernization of torpedoes, the manufacture of primers, tracers, fuzes and torpedo igniters, and the manufacture and conversion of torpedo material for service use. An extensive program for the modernization of torpedo war heads was commenced. Torpedo outfits were issued to eight new cruisers and two new submarines.

Research work was continued, including experimental launching of torpedoes from destroyers and aircraft. Proof and experimental runs of torpedoes were made from the barge. A large number of torpedo runs were made from the school barge and from destroyers assigned for the instruction of officers and men.

Thirty-six officers received instruction at the Officers' Torpedo School and 123 men graduated from the Torpedomen's School. Fifty-one men received instruction in diving to depths of 90 feet.

Work on torpedo allowance lists for ships and combined stock and allowance lists for tenders and bases was completed. These lists will increase the facility of supply of torpedo parts.

Installation of a chromium plating plant was completed, and work of chromium plating torpedo parts subject to wear and corrosion was commenced. Laboratory work has resulted in the development of improved bearing metals, and in increasing the scope of inspection methods.

INSTALLATION of new machine tools, and a large number of machine tools obtained from the naval ordnance plant at South Charleston,W. Va., and the naval torpedo station at Alexandria, Va., has reduced production costs. Refinements in the methods of planning, and rearrangements of machine tools on hand have also reduced costs of production.

The naval torpedo station, Keyport, Wash., has continued the modernization of torpedoes and exercise heads, and continued the work of reloading and converting torpedo igniters. Issues of torpedoes, and torpedo equipment, to vessels based on the Pacific Coast and on the Asiatic Station were continued. A Mark II dynamometer tank was received and is being installed.

Vessels of the battle force have continued to use the facilities of the naval torpedo station, Keyport, for overhaul and proving of torpedoes. The air flasks of all torpedoes modernized, as well as those of ships' torpedoes overhauled at the naval torpedo station, Keyport, have been electroplated.

Work at the naval torpedo station, Alexandria, Va., has consisted of upkeep and preservation of the plant and of the torpedoes in storage, and of the shipment of a large number of machine tools for use by other naval activities.

Under the provisions of the act of August 29, 1916, as amended by the act approved May 11, 1928, on May 1, 1931, two lieutenants who have had postgraduate instruction in ordnance were designated for engineering duty only (ordnance).

# The Gâvre Commission, 1829-1931

## *Notable Record of the French Naval Artillery Proving Ground*

By Donald Armstrong*

EARLY in 1919 five or six American artillery and ordnance officers who had spent several weeks at the Bourges proving ground of the French Army met at Lorient on the southern coast of Brittany to visit the Navy's proving ground at Gâvre. For some of these officers, especially those of the old army, there was a feeling of keen anticipation at the thought of visiting this place. Gâvre had long been a name well known to American students of ballistics, and justly so. Their estimate of the Gâvre Commission is typified by the recent comment of Brig. Gen. Alston Hamilton to the writer: "The work of the Gâvre Commission was accepted by me as of the highest grade; and I depended on such data of their's as I could secure to indicate closely the true experimental facts."

The Main Front at Gâvre, 1930. *Memorial De L'Artillerie Francaise.*

At first sight Gâvre was not particularly impresssive. Lacking much of its pre-war matériel which had been taken to the front for use against the enemy, the equipment available could hardly compare with that of our own proving ground. But the significance of Gâvre was not its equipment of guns and instruments. The temporary deficiencies of those days which have been more than made good since then and the anachronism, to American eyes, of the horse car which continues to do its duty there were forgotten in the realization of the achievements of those selected naval artillerymen, known as the Gâvre Commission. Here was an artillerey board which, at that time, had been carrying on its functions for nearly 90 years. With a notable continuity of effort each succeeding generation had built upon the accomplishments of the preceding one until the Gâvre Commission had become world renowned among the fraternity of artillerymen and ordnance experts. That was the preponderant thought as one disembarked from the naval launch at Gâvre at the entrance to the port of Lorient. Closer acquaintance with the personnel of the Commission, both active and retired, increased our respect for this extraordinary organization. General Charbonnier, the well-known ballistician, the originator of many valuable ideas in artillery design; Chief Engineer Sugot, the author of a new system of ballistics; Chief Engineer Garnier, the expert on anti-aircraft fire, were only a few of the many naval artillerymen

*Ordnance Member, Field Artillery Board, Fort Bragg, N. C. Formerly Assistant Military Attache, Paris, France. Major Ordnance Department, U. S. Army.

who heartily welcomed the American officers on this first visit and the others which followed in subsequent years. It is consequently an undertaking in which the writer feels it a privilege to engage to associate Army Ordnance in a somewhat belated recognition of the centenary of the Gâvre Commission.

FOR it was on June 22, 1829, that orders were issued to establish this proving ground for the Royal Navy where experiments could be made to determine "the measurement of ranges, the precision of fire, the muzzle velocity of solid and hollow projectiles, and the effects which they produce on the sides of warships." This quotation of the original order is taken from a monumental work on the history of the Gâvre Commission by General Patard of the Naval Artillery.[1] The writer is indebted to General Patard for much of the data used in preparing this historical sketch of the Commission.

It would be interesting to describe in detail these first experiments with smooth-bore guns (commenced in the summer of 1830) and to study the methods of the Commission in the early stages of its investigations, but space does not permit. At the end of the first decade the Commission published the results of its experimental firings. With the assistance of the distinguished Professor Hélie, the secretary of the Commission, the publication in 1841 of this manual supplied the French Navy with its first range tables. Here at last were the long-sought-for data on range-elevation relationship, muzzle velocity, and penetration in wood. The experimental method in ballistics was finally sufficiently perfected so that the results could be systematized by means of empirical formulae.

There was one astonishing experiment performed in 1844 to disprove the contention of a certain Piobert that the Gâvre range tables were incorrect because ranges at sea were less than ranges on land, all other conditions being equal. Piobert held that a projectile fired on land had a tendency to rise because the air displaced by the projectile could not escape so readily downward on account of the resistance of the ground as it could upward. When a gun fired over water, however, the surface of the water yielded, and the air did not lift the projectile as much as in firing over land. Of course the tests put an end to this fallacy, which curiously enough was of long standing since it is found in some French gunnery instructions of 1610.

The introduction of rifled cannon and cylindrical projectiles dates back to an order to the Gâvre Commission of July 22, 1845, in which comparative tests of muzzle-loading rifled guns and smooth-bore guns were prescribed to determine "if rifled guns had advantages in range and accuracy compared with the ordinary guns, and to decide if they should be substituted for them in the armament of our war ships."

THE acrimonious discussion in the Navy of the relative merits of the two types of artillery ultimately decided in favor of the views of the Gâvre Commission, gave the Commission its great prestige which it has never lost since. In 1846 the rifled carronade was found to give a range of 1938 meters, and lateral and longitudinal deviations of 7.60 meters and 70.5 meters while the smooth bore carronade gave a range of 1638 meters, and deviations of 38 and 142 meters.

The superiority of the rifled gun was immediately accepted by the Commission. But there was much opposition from the die-hard supporters of the smooth-bore artillery. They contended that the smooth bore was the better gun, and that it could fire properly designed elongated projectiles. The Commission patiently carried out tests to refute this argument. It was ready to propose a system of rifled artillery when the Crimean war occurred. In September, 1855, ten rifled guns complete with their ammunition were shipped to the Crimea. The Gâvre Commission designed these guns, carriages and projectiles, prepared the range tables and the drill regulations. At that epoch it was a veritable technical staff, proving ground, and artillery board, as we know them, combined in a single organization. This method of operation continued during the years that the rifled artillery was being perfected up to the introduction of the Model 1870. About that time the broad functions of the Commission diminished somewhat. After 1870 it was no longer so influential in determining types of matériel. Its advice was no longer requested concerning the suitability of a matériel for its designated use. The Commission found much to accomplish in its efforts to perfect range tables with the new firing conditions imposed by the greater muzzle velocities and ranges and new projectiles and powders that were characteristic of the rifled guns. The period was marked by the design and introduction of new instruments to determine velocities and pressures. The law of the resistance of the air was determined and new methods of interior and exterior ballistics were created during these years.

The outbreak of the war in 1914 was soon followed by feverish activity at Gâvre. New matériel had to be studied, old matériel was modified for use at the front, more than five hundred range tables were calculated, antiaircraft trajectories were studied. Gâvre carried out many investigations during the war for the French War Department, such as studies of improved forms of projectiles and armor protection for tanks. The first projectiles with false ogives fired at the front in 1915 were 194-mm. shell designed and tested at Gâvre.

WHAT has been the role of Gâvre in the decade since the war? General Patard writes: "New projects were not lacking. Problems born of the war were numerous. Experience both on land and sea had shown that guns had always had to fire at their maximum range. Hence the very natural idea of seeking to realize a more powerful artillery. The Commission anticipated that it would have to study an entire series of new matériel. In seeking to increase ranges, projectiles of new form had been used. Their ballistics remained to be studied entirely, as well as the repercussion of their form on their effectiveness.

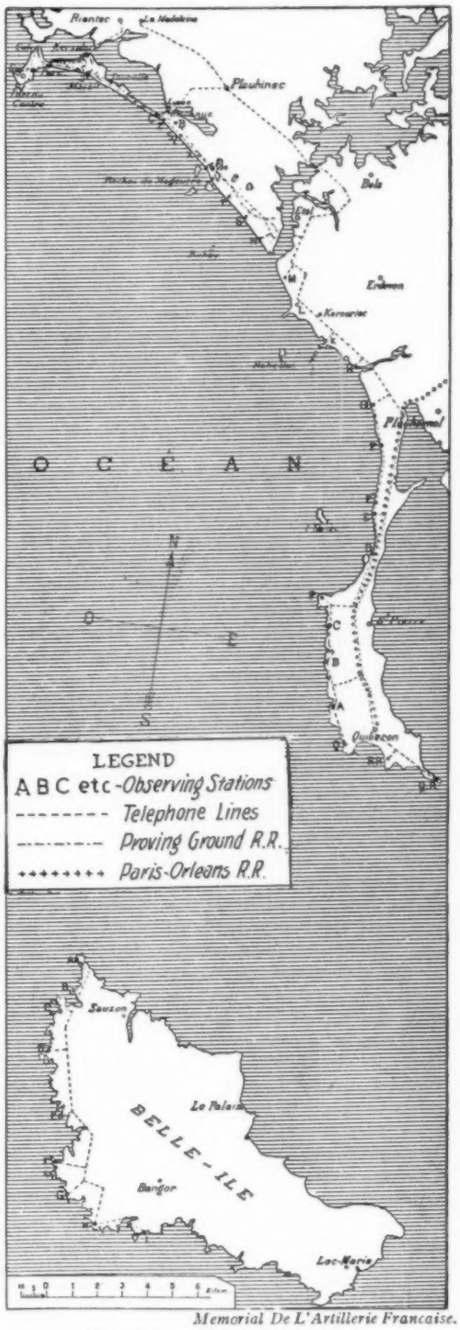
"Other types of shell had been created for new purposes, such as illuminating, smoke, tracer, incendiary, etc. They were hardly perfected even for land warfare. The investigation of these shell had to be undertaken with a view to their adaptation to naval matériel."

Gâvre thus undertook to solve many of the pressing problems of the artillerist and design engineer which the needs of the war period had thrust upon similar institutions.

1. Historique de la Commission d'Expériences de Gâvre 1829-1930. By Engineer General Patard, French Naval Artillery.

These and many other problems necessitated the physical overhaul of the Gâvre equipment. But prior to that an interesting study was undertaken. A Naval Artillery Board presided over by General Charbonnier, the equivalent in the French Navy of our Westervelt Board, concluded that Gâvre was absolutely inadequate for future requirements. The Board found further that Gâvre could not be transformed to meet modern needs. It offered the radical recommendation that arrangements be made with the War Department for the creation of a new proving ground for joint use of the Army and Navy. This idea was the outgrowth of the satisfactory coöperation between the two services at Gâvre during the war. The arguments supporting this plan were the known desire of the War Department for a proving ground for the very long range guns which it intended to develop, and the obvious economy of such a move in time, money and energy. General Charbonnier hoped for an even greater collaboration between the Army and Navy. He recommended the complete fusion of the Army and Navy Ordnance Departments. On account of numerous insurmountable difficulties both plans eventually fell through. Gâvre was destined to continue as the seat of the famous Commission.

Beginning with 1921 many improvements were made to the old proving ground, and its activity was considerably augmented. In a recent year, four times as much firing took place as occurred in any year before the war. A new law of air resistance has been determined for modern projectiles. It is now possible, using the tables based on this new law in combination with the Garnier tables of atmospheric variation as a function of the altitude to interpret ballistic firings by means of a constant ballistic coefficient. Moreover it is possible to evaluate this coefficient very closely from a consideration of the design of the projectile alone. The empiricism necessitated by the irregular variations of the ballistic coefficient when using the old law of air resistance with modern projectiles is accordingly destined to disappear. In addition to the ballistic studies, Gâvre proved again in its tests against the THURINGEN the notable superiority in the attack of armor plate of armor-piercing shot over shell, of the thick-walled steel projectile with comparatively small charge of high explosive to the large capacity thin-walled shell.




*Memorial De L'Artillerie Francaise.*

**The Gâvre Proving Ground.**

Much of the accomplishment credited to the Gâvre Commission is due to what these naval artillerymen call the spirit of Gâvre. This is admirably summed up by General Patard when in answer to his query: "Of what does this spirit consist," he writes: "It consists, above all else, in a faith in experimentation, but in experimentation well prepared, well executed, and the results of which have been studied down to the smallest details by the officers themselves. New theories are accepted as guides, but with a faith mingled with skepticism, accepting these theories as valid only after prolonged tests.

"It demands very great scientific integrity, the steadfast determination to make no compromise with oneself in interpreting results.

"It includes, finally, complete liberty of discussion. The President directs the studies, commands the execution of the tests, but around the conference table opinions have no insignia of rank; their weight is a function only of the value of the reasons supporting them. Presidents have been seen in the minority—and not the least of them. They haven't resigned for that reason."

TODAY the Gâvre Commission is an integral part of the French Naval Ordnance Department (*Service Technique de l'Artillerie Navale*). Presumably its organization comprises three main divisions: (I.) Acceptance test division; (II.) Exterior ballistics division; (III.) Interior ballistics division. Specialization is accepted as a necessity, but every effort is made to avoid the separation of the various sections into water-tight compartments.

The personnel of this naval commission is noteworthy. It includes the following categories:

I. Regular members—including the directing personnel of the naval artillery, with the addition of line officers of the Navy, naval engineer officers, army officers of both the home and colonial artilleries. The number of line officers of the Navy is kept as great as possible to insure the effective participation of the using services in tests of new matériel. All these members participate in all the operations and have a vote in the conferences of the Commission.

II. Junior members—first class engineers of the naval artillery who have served less than a year with the Commission. These have no vote in the deliberations of the body.

III. Student officers—second class engineers of the naval artillery.

IV. Assistant members—reserve personnel,—qualified commissioned officers and enlisted men, whose active duty service is performed with the Commission.

V. Associate members—civilians having no military obligations but who are especially qualified by reason of their scientific attainments for assignments to studies concerning ballistics, powders, explosives, meteorology, measuring instruments, etc.

In addition there is a corps of administrative officers, civilian experts, enlisted personnel and laborers to perform the operations of the proving ground.

THE notable development that has taken place since the war in the equipment available for the Commission is shown by the comparison of a few figures. In 1914 there were 69 guns and 32 carriages of various types at Gâvre. In 1930 there were 255 guns and 72 carriages. These carriages include three so called "universal carriages"; one for guns of "large and very large calibers," one for large and medium calibers, and one for small calibers. The largest universal carriage will support the largest caliber gun that can reasonably be anticipated. The gun mounted on it can fire in all azimuths. It is a self-propelled carriage so that it can move from one firing position to another. A traveling crane of 400 tons capacity has been installed at the proving ground to facilitate maneuvers. The Le Boulengé-Bréger chronograph remains the type instrument for measuring velocities. Metallic masts 40 to 80 meters high have been installed to enable the measurement of velocities up to angles of elevation of 30°.

To locate points of fall, observing stations have been established at convenient places along the shore and at Belle Isle, an island off the coast. These stations are connected by telephone or wireless to the proving ground. Ranges can be accurately measured and instantly reported up to a maximum distance of about 50 kilometers.

What is the *modus operandi* of the Commission with the tools at its disposal? A senior officer is designated in charge of each test with the number of commissioned officer assistants required to make all necessary observations. Each officer submits a report of his observations to the officer in charge at the conclusion of the day's tests. A partial report which is simply a statement of facts with no expressions of opinion is prepared at the conclusion of each session. When the Commission's Secretary who has prepared the program of tests, finds that the program is completed, and that a conclusion may be reached, he makes up a report from the partial reports of each session. This goes to the president who studies it for omissions and obvious errors. It is then circulated and commented upon by each member of the Commission. The Secretary then discusses the comments with each member individually and modifies his report when necessary. The report is read aloud at a full meeting of the Commission when it receives its final form for submission to higher authority.

This inadequate commentary on the life and works of the Gâvre Commission fails to do justice to the occasion. Fortunately, the renown of the centenarian is such that the form and substance of this interpretation of its history is of slight importance. With its hundred years of notable achievement, with its many traditions, the natural outcome of its long career of great national usefulness, with the prestige of the many famous ballisticians who have added luster to its name, the Gâvre Commission has won a secure place of honor among scientific and technical establishments of the military and naval organizations of the world.

**Explosives Clear the Channel at Miami, Fla.**

# Optical Glass in America

## *An Important Thread in the Fabric of National Defense*

By Henry F. Kurtz*

ANY optical instrument consists of an optical system adequately housed in and supported by mechanical parts. If the optical parts are not good enough to perform the tasks expected of them, no amount of skill or precision or ingenuity expended on the mechanical parts can make a useful optical instrument of the combination. Neither can any amount of ingenuity on the part of the optician (lens designer) or skill on the part of the workman who makes the optical parts, make good ones from inferior optical glass. Just as no chain is stronger than its weakest link, no optical instrument can be made better than the quality of optical glass permits.

Fire-control instruments are required to present images to the observer of the highest quality in respect of definition and brilliance. This fact imposes upon the maker the use of only the finest optical glass. The instruments are subjected to the shock of gun fire and to abuse incident upon the conduct of military operations. They are exposed to all kinds of temperature variations and weather conditions prevalent in all climates. The latter two facts impose the conditions that the glass used must withstand mechanical abrasion when the lens surfaces are exposed, and that it must resist the chemical attacks of smoke, fog, dust, sea air and moisture.

**Optical Glass, the Raw Material With Which the Optical Engineer has to Work.**

Subsequent processes may include flattening to the form of a plate while heated to plasticity, cooling, grinding and polishing the surfaces of the plate and invariably a final inspection.

Glass has two properties which make it a useful raw material for optical instruments. One, of course, is its transparency, while the other is its ability to bend a ray of light upon incidence at its surface. When a ray of light falls at an angle upon a glass surface its direction is changed so that the angle between it and a normal to the surface is smaller after passing the surface than before. The amount of this difference varies for each kind of optical glass. It also varies with the wave length of the light for any kind of glass. A coëfficient which serves to measure the degree of this bending has been established by physicists and it has been called the refractive index. The symbol assigned to it is the letter n followed by a subscript indicating wave length. For example, nC would be used to designate the index of refraction for light of the wave length of the C line of the Fraunhofer spectrum, that is, one of the hydrogen red lines. The refractive property of a glass is usually designated by the refractive index for the sodium D line and is written nD. It is called the mean refractive index and by convention the subscript D is frequently omitted. It is to be understood that the mean refractive index varies for different kinds of glass.

It was indicated above that the refractive index varies with wave length for any given glass. This property is known as dispersion. The rate of change of refractive index with wave length is an important coefficient to the optical engineer. The measure of it was established by Ernst Abbe, a German, and the Greek letter $v$ has been assigned to it as a symbol. It is as follows:

$$v = \frac{nD - 1}{nF - nC} \text{ or } \frac{n - 1}{nF - nC}$$

Strictly speaking, the above number is a coëfficient of dispersion but it is almost universally alluded to simply as the dispersion. It, like mean refractive index, varies for different glasses.

It is to be noted that as the value of the number representing mean refractive index increases the refractivity of the glass increases while on the other hand increase in the number representing coefficient of dispersion indicates a decrease in dispersion.

Optical glasses suitable for the manufacture of fire-control instruments have constants lying between the following two limits:

| Designation | Mean Refractive Index = nD | Dispersion = $\frac{n-1}{nF-nC}$ |
|---|---|---|
| Ordinary Crown | 1.511 | 60.6 |
| Extra Dense Flint | 1.648 | 33.8 |

The optical engineer in designing his refractive elements is forced to choose glasses lying within these limits, and while there are several of them, distinct limitations are imposed upon him. A measure of an optical engineer's ability, then, is the skill with which he chooses glasses to endow his instrument with desirable properties to the fullest extent possible. It is conceivable that much more desirable instruments could be made if glasses with higher and lower refractivities and dispersions could be made. Some such glasses are made, particularly having higher values of these

*Scientific Bureau, Bausch and Lomb Optical Co., Rochester, N. Y.

**The Glass Pots, Having a Capacity of the Order of 1000-lbs. of Glass Each, in Process of Making.**

They are made by hand of a mixture of burned and raw fire clay as free from adulteration as can be secured.

constants, but their physical properties and cost are such as to preclude their use for fire-control instruments, excepting in rare cases.

When the optical engineer prescribes one of the types of glasses to be used he must usually have its refractive index held to one unit in the third place and its dispersion coefficient held to one-tenth. These tolerances are met only by the most painstaking care in selection of materials and the most meticulous care in the manufacturing processes. They are in fact the uttermost limits of accuracy to which glass can be made.

The reflecting elements used, such as prisms, require glass of the excellent quality in respect of physical properties, but the requirements for refractive index and coefficient of dispersion are not nearly so exacting. The glass must be limpid, clear and free from imperfections but variations in optical properties that would utterly preclude its use for refractive elements are wholly acceptable for reflecting elements.

OPTICAL glass is made by melting together a mixture of ingredients called the batch in a specially built refractory crucible in a specially built furnace. The exact composition of the batch depends upon the type of glass to be made. It consists of mixtures of sand, sodium, potassium, and calcium carbonates and aluminum oxide together with certain other oxides added to impart the particular optical properties desired. These ingredients must be so incorporated by stirring and heat control that, when finished, the glass is a clear limpid body, free from gas bubbles, inclusions and variations of refractive index either local or extended. The local variations in refractive index will usually be manifest as striae, or cords of different refractive index from that of the surrounding medium. The variation may be great or little and the cords may be large or so fine as to be discernible only with the greatest difficulty. Gas bubbles do not usually affect the performance of an optical instrument as seriously as striae do but they are undesirable and will render the glass useless if present in great numbers or if they are large in size. It is quite impossible to make a pot of glass (batch weight 600 to 1500 pounds) entirely devoid of either, and those parts of the glass containing such imperfections in them must be discarded.

**Making the Stirring Rods.**

**The fire clay used must be as pure as that used in the pots.**

**Glass Pots "Curing."**

A pot must stand for a minimum of six months to assure freedom from moisture and to permit other ageing processes to mature. Only after this period is it safe to give the pot its preheating preparatory to the introduction of the batch.

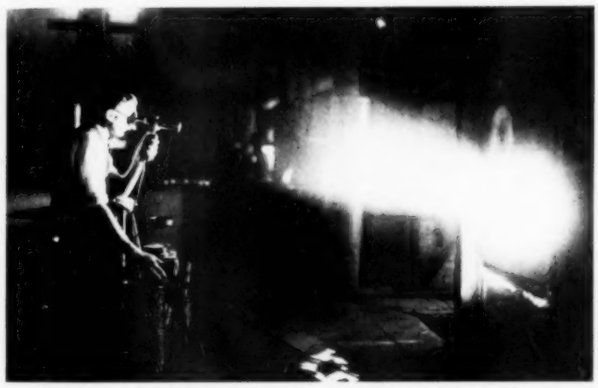
Optical glass cannot be poured or manipulated while in the molten state like ordinary glass for common glassware. The pot containing the optical glass must be allowed to cool slowly over a period of several days, after which it is broken up into fragments. The fragments are inspected and those parts containing an excessive number of bubbles or any striae are rejected. The yield of useful glass will average 20 to 30 per cent of the glass contained in the pot. A yield of 35 per cent is extraordinarily high, and to the best of the writer's knowledge is not regularly attained by any manufacturer of optical glass in the world.

It is always desirable to have a fire-control instrument operate as effectively as possible under conditions of poor illumination. This means that all the light entering an instrument must be as completely conserved as possible and forced to contribute to the brightness of the image. The glass used in fire-control instruments, therefore, must have a high degree of light transmission. Good optical glasses should absorb no more than 0.3 to 0.6 per cent of the light

per centimeter, depending on the type of glass. The glass should be colorless, since color connotes selective absorption, that is, absorption of some wave lengths more than others.

The variations in refractive index and dispersion are produced by variations in the fundamental batch proportions and the addition of certain metallic oxides. For instance, the addition of lead increases mean refractive index and dispersion. It also inevitably tinges the glass a light yellow color. Such lead glasses are known as flint glasses. If all the ingredients are of the highest purity, the flint ordinarily useful for fire-control instruments is so lightly tinged with yellow that the color is almost imperceptible. The glasses to which lead is not added are in general known as crown glasses.

Colored glasses are made by adding small quantities of other metallic oxides. For instance, gold is used for ruby glass, cobalt for blue glass and didymium for a purplish glass. It is obvious that if it is desired to make colorless glass, great care must be exercised to prevent the adulteration of the batch or the molten glass by impurities. Faint traces of iron, copper, nickel, cobalt, chromium, vanadium or manganese will color the glass or impair its light trans-



**Reading the Temperature of the Heated Pot with an Optical Pyrometer.**

mission. To prevent the presence of these and other undesirable adulterants requires ceaseless control and analysis of the materials used both in the batch and in the making of the pots. The pot and stirring rod must be sufficiently refractory and free from adulterants to resist solution in the molten glass, and stable enough to resist disintegration. The furnace must be so constructed that particles will not drop from it into the pot and the incandescent gas must contain no vapors soluble in the molten glass.

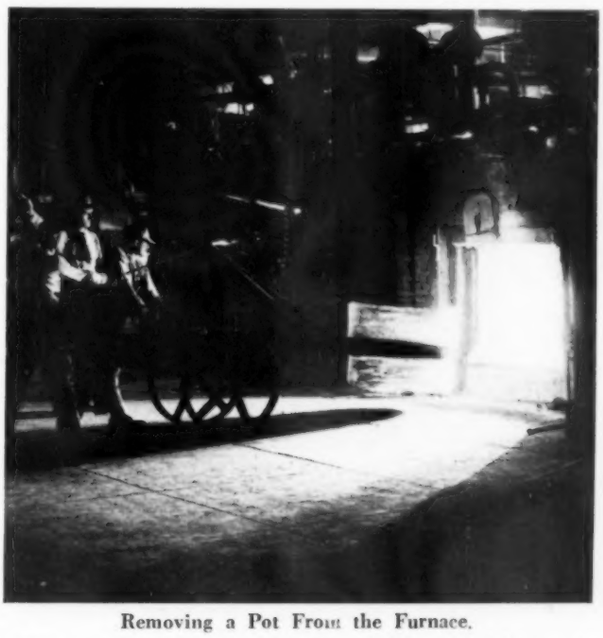
To summarize, then, optical glass must meet very stringent conditions of refraction, dispersion and dispersion ratios; it must be free from bubbles, striae and other inclusions; it must be highly transparent; it must be as nearly colorless as attainable purity of materials and batch composition will permit; and lastly it must resist abrasion and action of weather and certain chemicals resident in sea air, smoke, dust, etc.

THE meeting of these conditions requires such care in the way of control of material and processes that many of the materials, which are used in varying quantities throughout the entire technique, must be specially made either by manufacturers of chemicals or by the glass plant itself.

**Compounding the Batch Preparatory to its Introduction to the Mixer.**

The mixer is similar to a concrete mixer which is operated until the distribution of the ingredients is uniform throughout the batch.

Previous to the World War optical glass was procurable in Europe, principally in Germany, of such quality as to meet satisfactorily the requirements summarized above. The entire world market for optical glass was not large enough to warrant the investment necessary to the development of a competitive American establishment with the attendant expensive research. As long as glass was obtainable in Europe, no American manufacturer felt justified in attempting its production in the face of the known tremendous difficulties and small demand. In spite of these recognized facts the Bausch and Lomb Optical Company appreciated



**Removing a Pot From the Furnace.**

The temperature is of the order of 2600° F. The pot is allowed to cool slowly while imbedded in a jacket of fuller's earth, kieselguhr or other insulating material.

the desirability of independence from foreign sources of supply, and as early as 1912 carried out some experimental attempts to make optical glass, but with indifferent success. This, then, was the situation in America upon the advent of the war. Existing stocks of glass were soon exhausted and America was forced to choose between making its own optical glass or stopping the production of optical instruments. The latter, of course, was unthinkable, and forces were mobilized for an attack upon the problem. The Bureau of Standards and the Geophysical Laboratory contributed their services. The Pittsburgh Plate Glass Company, the Spencer Lens Company, Keuffel and Esser, and the Bausch and Lomb Optical Company all built glass

**A Cooled Pot Broken Into Fragments.**

The fragments are inspected for flaws. The proportion rejected is of the order of 70%. Subsequent inspection will generally increase this to the order of 75% to 80%.

plants. That at the Bausch and Lomb plant was, as was to be expected, the largest. The demands of this company were probably many times in excess of that of the other companies.

The early experiments were discouraging. Not all the conditions could be met simultaneously. The early glass was colored, low in transmission, chemically unstable and not free from bubbles, striae and stones. The demand for binoculars, small range finders and battery commander's telescopes was tremendous and the Army became more and more insistent on delivery. To relieve the situation the use of this inferior glass was ordered. As a result thousands of optical instruments were turned out into the world containing inferior glass. But we were facing a national emergency and these instruments had to be made and used, despite the glass available was known not to be all that could be desired.

It is unfortunate that many of these instruments, notably binoculars, are still in existence. They were easily available shortly subsequent to the war. Each one of them appears to stand as an example, to users who do not know the facts, of what America produces in the way of optical glass. Even at this late date they come to light to rebuke the manufacturer of the binoculars or of the glass in them for his very best effort to provide our military forces with something which, while not ideal, was infinitely better than nothing. The wonder is not that the glass produced in the course of a few short weeks was not ideal but that even a single pot of glass of doubtful quality should have been produced in so short a time.

Progress has not been at a standstill since the close of the war. All the smaller plants have gone out of existence for want of demand, except the Bureau of Standards plant where experimental work is still done. The Bausch and Lomb plant is still actively engaged in the production of large quantities of optical glass and to the best of the writer's knowledge is the only plant in America making it commercially. The glass produced in this plant today is of such average quality that it surpasses that available in Europe.

FIRE-CONTROL instruments play an exceedingly important part in the successful conduct of warfare, and it is apparent that steps should be taken to make them immediately available in the event of an emergency. The methods of warfare change constantly and it is manifestly impractical to have on hand a large stock of completed optical instruments. Progress in the art of warfare would undoubtedly render them obsolescent if not obsolete before occasion arose to force their use. But a relatively small investment would permit a group of competent optical and military engineers to keep abreast of development and to keep available consummated designs of the most necessary and effective instruments. The supply of optical glass extant is pitifully small when measured against the caliber of the instantaneous demand that an emergency would provoke. To make a supply available in the short time that would be at hand, assuming the development work to have been kept up to date by such a group, would be utterly impossible. It takes an absolute minimum of six weeks of time to carry one pot of glass through processing, assuming pots to be ready. A pot has to "cure" over a minimum of six months before it is available for use. It takes time to make good optical glass and when time is not available the glass will not be good. The supply of optical glass would surely comprise a bottle-neck again in case of war and it would be nearly but not quite so constricted as it was in the past war.

The solution of the problem seems to lie in the accumulation of an adequate supply of the most commonly used glasses, which number only eight or ten at the most. This supply should be carefully stored and catalogued in respect of its optical properties, physical condition and size of pieces. The effectiveness of the whole structure, however, would depend on the judgment and care with which the glass were disbursed when the need came. Such disbursement would perforce be unreservedly in the hands of a personnel thoroughly familiar with the possibilities, the limitations and the practices of both the optical engineer and the glass maker.

The above sets forth the position of America in respect of optical glass, that small but tremendously important thread in the fabric of national defense. We have the material, the funds, the experience and the men with which to provide ourselves with means to direct our gunfire.

# The Purification of Cellulose

## *A Suggested Improvement in Smokeless Powder Specifications*

By James F. Monaghan*

IT is noticeable that all prevailing specifications for the manufacture of smokeless powder give no definite procedure for the purification of the cellulose used in making nitrate of cellulose powder for cannon. From a textile point of view this is in error. The treating of cellulose is essentially a textile problem, and should be considered in no other light. That is, the cotton in whatever form it enters the initial processes should be treated with the same care and procedure of the most exacting bleach in the best quality of textile fabric. It is incredible of belief that the procurement of this material should be satisfied to allow impure cellulose to be sent to the nitrators and there acid-treated in the presence of impurities which would, if present in the same amount, wholly destroy any process of dyeing or finishing that might be carried out on a similar cellulose.

Specifications governing the manufacture, test and inspection of smokeless powder for cannon generally read that the material used for nitration shall be bleached cellulose, prepared for nitrating by purifying unspun cotton wastes, or suitable short-fibered commercial cotton, and thoroughly washing to remove the purifying material or salts; that it shall contain 0.4 per cent or less of extractive matter, not more than 0.8 per cent of ash; that it shall be of uniform character, clean and free from lumps to prevent uniform nitration. Overbleaching is to be avoided; the bleached cotton shall not contain over 7 per cent of material soluble in 10 per cent potassium hydroxide solution on heating for three hours at 100° C.

The highly reactive impurities in cellulose thus treated are inherent from the processes through which the cotton has passed, and they will be present in the nitration pots to slow down the chemical reaction, and as alterants to produce results differing from the reactions expected. The bleaching of cellulose, or cotton, which in its pure form is almost wholly pure cellulose, may be done commercially in several ways. Cotton bleachers have their own ideas of bleaching and these vary somewhat with the plants interested. The bleaches generally used are the peroxide of sodium bleach, the peroxide of hydrogen bleach, the lime and ash chemic and the caustic soda chemic bleach. The first two are highly satisfactory as far as purity goes, but their costs make them prohibitive in powder-making procedure. They will not be further discussed here beyond a statement that their products do not contain any undesirable bleach residues to interfere with nitration and colloiding, except that in the use of the sodium peroxide, the influence of the sodium-cellulose combination is a drawback. The discussion will be limited to the use of the chemic bleaches.

COTTON is boiled in an alkaline solution to saponify the natural vegetable oils, fats, waxes and resins in the fibers, the animal fats and oils added in the sizing if yarn and wastes are used, and to emulsify any mineral oil or grease present from machinery or process contact. The whole process, is designed to remove all extractive matter. After the boil, the saponification or emulsion is removed by a water wash and a treatment in an acid to further care for the alkaline soaps and emulsions formed. The acid residues are thoroughly washed out. The next step is the actual, i. e., the chemic, bleach.

In kier boiling the cotton may be treated in the so-called lime and ash boil, really a two-boil process, in which the cotton is boiled first in a milk of lime solution under a pressure of 5 to 10 pounds gauge for six hours, washed free from the lime, and treated for a second boil in soda ash under the same time and pressure conditions, with the ash content at 6 to 8 per cent of the weight of the fiber. After the second boil the cotton is water-washed and acid-treated with sulphuric acid for clarification.

This system of boiling produces the best cellulose, with a retention of the shade of white attained. This is because there is no formation of sodium-cellulose compounds to turn the mass yellow on oxidation and is the chief advantage of the lime and ash boil. Where the purest form of commercial bleached cellulose, lasting in quality, is desired, this method of boiling is to be favored. The disadvantage in emergency production however lies not merely in the cost of the processing but also in the length of time required for the two boils over that of the one-boil caustic soda process.

In the caustic soda treatment the cotton is given one six hour boil under 5 to 10 pounds gauge pressure in commercial sodium hydrate standing at 6° to 8° Twaddle at 60° F. After the boil a thorough water wash is given, and the cotton is acidulated in sulphuric acid. In many cases cotton boiled in either process will show iron oxidation stains, either localized or uniform; these from contact or from treatment in water containing iron in solution or suspension. These stains may be removed by substituting a hydrochloric acid bath for the sulphuric acid bath after the wash-out of the kier. The hydrochloric acid is expensive and should be resorted to only in the emergency of stain. It possesses all the qualities of sulphuric acid necessary for the removal of the alkaline soaps and possesses added advantage in that the hydrochloric acid gas given off in the bath and the chlorine liberated in the process of neutralization have a bleaching effect on the cotton in the presence of the oxygen of the atmosphere. This acid will tender cotton and produce hydrocellulose if allowed to dry in the fiber.

Therefore, if a bleacher takes on a contract for the purification of cellulose he will undoubtedly use the caustic soda boil, and acid treat with sulphuric acid when he bases his contract deliveries on cost and time. Against this boil however must be considered the disadvantages of the sodium-cellulose formations which start deteriorations immediately on the drying of the cellulose in the atmosphere or on dryers.

*Consulting Engineer, Boston, Mass. Colonel, Ordnance Reserve, U. S. Army.

MUCH of the kier boiling in this country is done in vessels in which the liquor is boiled by means of steam issuing from an open-end steam pipe or distributed in the liquor through a perforated coil. The steam, the charging water and the alkaline liquor contain air, and the steam and the entrained air in contact with the cotton under the temperature due to the pressure, act as oxidizing agents and tender the cotton, producing oxy-cellulose. This defect maintains through all the later processes, as a resist to the bleach, as a destructive medium in the high temperature of the drying, as a resist in the nitration, to present insoluble inerts in the ether-alcohol treatment.

It is advisable to use kiers fitted with outside tubular heaters and pump circulation to keep the steam from contact with the cotton. The charging liquor should be boiled in jacketed kettles to remove the air. When the kier is put into operation, the air in the cloth and charging water should be allowed to escape through an atmospheric vent until the charge comes to a boil, when the whole may be closed to allow the pressure to build up. These dilute alkaline solutions do not injure cotton if air is excluded from the processing.

Many bleachers use assistants, such as resin, to hasten the saponification and emulsification in the kier to form a resin soap with the sodium hydrate and aid in scouring, bisulphite of soda, various soaps, and trade-named reagents innumerable, but these do not help. Good strong positive and uniform circulation of the liquor throughout the mass of cotton, with constant temperature and pressure through the time of boil are all that is required, and the addition of assisting reagents does nothing more than complicate the reactions within the kier and increase the difficulty of the removal of the residues after the boil is finished.

When the lime and ash method of boiling is used many bleachers give the cotton a water wash and a treatment in sulphuric acid after the lime boil to remove the lime soaps formed and clear the mass for later treatment. The cotton is then run into the ash kier for the second boil. Such a treatment is highly advantageous.

The actual bleach takes place when the cotton is treated in a bath of chemic, as a calcium hypochlorite or sodium hypochlorite, for the removal of the natural coloring matter of the fiber. The salts supply the required amount of chlorine for reaction in the presence of and in combination with the oxygen of the atmosphere, to effect the desired white. After this point has been reached the cotton is water-washed free from chemic, and treated in a bath of dilute sulphuric acid or in sulphurous acid, either of which will stop the reaction of the chlorine on the fiber. After a sulphuric acid treatment it is necessary to rewash thoroughly to remove all traces of acid before drying.

MOST of the trouble in bleached cellulose comes from the treatment after the chemic exposure. One of the chief sources of trouble is in the drying of sulphuric acid in the fiber. This occurs when soured or acid-treated cottons are allowed to dry in storage tubs. As the water evaporates on drying, the acid becomes concentrated until destruction of the fiber occurs. This acid dried in the fiber in air or dried on machinery will tender the cotton, and the tender sections will react chemically different from the remainder of the lot when exposed to later processes such as nitration or colloiding.

Most bleachers use calcium hypochlorite, or lime chemic, for the bleach solution, because of the resulting permanent shade in the bleached product. They err, however, in neutralizing the reaction with sulphuric acid, because calcium sulphate, insoluble in water, is formed on the addition of the acid to the chemicked fiber, and this together with quantities of free lime, acts to set up a resist against later processes of drying, nitration or colloiding. In the drying, the fiber will turn yellow to brown, due to the presence of the calcium sulphate and the lime. Washing will not remove these. Also, if the sulphuric acid is dried in the fiber, hydrocellulose will form, with a resulting tendering and a further resist to all later processing.

THE fiber should be anti-chlored with sulphurous acid after the chemic bath. This acid, reacting on calcium hypochlorite forms calcium sulphites soluble in water, with no free lime as a residue. These sulphites wash out in the final wash, and no after-resist or tendering will be evidenced. Fiber containing this acid may be exposed to the heat of commercial drying machinery without the possibility of injury in any way.

Sodium hypochlorite, as soda chemic, is used in cotton bleaching because it gives a lively development of a white. With a sulphuric acid neutralizing treatment, sodium sulphates are formed, with some free sodium. Both are soluble in water washing, with no after-process staining, resists or tendering on drying. It is safer, however, to use sulphurous acid as an anti-chlor because of the freedom from hydrocellulose formation and from danger in drying. Excessive use of concentrated chlorinated solutions of calcium or sodium will produce oxycellulose.

The most satisfactory bleach, the quickest, and the lowest in cost will be that obtainable with calcium hypochlorite anti-chlored with sulphurous acid, and washed free from residues in water. Sulphurous acid treatment will leave the cotton in a softer, fuller and more homogeneous condition than can be obtained with sulphuric acid. The fiber bleached in this manner will contain no residues to act as resists in nitration or colloiding, and the percentage of ash will be so low as to be almost indeterminable.

Cotton tendered by acid reaction becomes hydrocellulose, and indicates an increase in oxygen and hydrogen. Physical changes are not apparent until the fiber is heated in drying, when the natural color of the cotton turns yellow as it oxidizes, and finally becomes black at the high temperatures of drying, the shading depending on the intensity of the acid reaction. This cotton will also react to dyestuffs as indicators. Cotton tendered by the formation of hydrocellulose may regain some of its strength lost by mercerizing in sodium hydrate. This procedure, however, is not a profitable one.

This tendering reaction is the source of most of the uneven work in cotton bleaching and processing. The sulphuric acid used is the cause. After an alkaline boil and its subsequent acid neutralization, the cotton is generally safe. Sulphurous acid will not form hydrocellulose on cotton. This acid, however, should be removed from cotton by water-washing, within eight hours of the time of application to prevent its oxidation to sulphuric acid. Sulphurous acid as a volitile acid will not tender cotton if dried into it under the highest temperatures of commercial drying.

IN an analysis of prevailing specifications on the making of nitrate of cellulose powder for defects it will be evident that traces of calcium, chlorides or sulphates will ever be present in the cellulose bleached by the ordinary methods using sulphuric acid. Free calcium, and calcium sulphate as plaster of Paris, are insoluble in water and cannot be removed after they have become set in the fiber. They adhere to it as a blanket and prevent the penetration of reagents used in later processes. These will not be present in bleached and washed cellulose if sulphurous acid is used after the chemic treatment, because no free calcium is present, and the residues are soluble. Ash will be present after sulphuric acid treatment. After the sulphurous acid treatment the ash may be entirely absent. With the sulphuric treatment it is impossible to obtain cellulose of a uniform character since the formation of hydrocellulose, or oxycellulose, will produce localized inert masses of fiber, to produce a non-homogeneous material. These local isolations are not uniform as compared each to each. Thus a variable impurity must be considered. With the sulphurous acid treatment no oxy- or hydrocellulose is formed. This advantage would aid in securing more uniformity in blending.

It is believed by the writer that a nearer approach towards the preparation of one definite nitrate than is reached today would be realized if the impurities now sent to the nitrators after the present day methods of cellulose preparation and bleach were removed by substitution for the bleach treatment advised in this discussion. Without a doubt, all impurities inherent from the bleach will interfere with nitration and will cause to be produced any degree of nitration from that desired down through the undesirable levels of nitrogen content to a point of no nitration whatever. Also, the reactions of the mixed acids on improperly prepared cellulose will be incomplete, or even superficial, and will make for instability. This instability will increase as the after-bleach impurities increase. The impurities will retard the speed of reaction in the nitrating acids. The removal of the impurities will assist any stabilizers used in the colloid.

THERE is no question in the mind of the writer that the processes recommended here for kier boiling and for the bleaching of cotton will produce anything other than satisfactory results if applied to the purification of cotton for powder manufacture. In the writer's own experience of more than thirty years in the bleaching, dyeing and finishing of cotton fiber, yarns and piece goods it has developed that the procedure advised has been the one to follow when quality was desired. After years of constant experimentation the use of sulphuric acid was eliminated from quality consideration, and uniform work was always obtained. As a result the writer has installed scores of sulphurous acid-making plants in the textile bleacheries in this country and abroad, and caused the use of sulphuric acid to be rejected immediately.

The advantages of the sulphurous acid treatment are: lower cost for materials used; reduction in time of chemical treatment; reduction in labor, power, water demand, floor space, machinery equipment; quality, uniformity and permanency of production, and absolute freedom from impurities as inerts and reagents to later act as resists to defeat attempts at uniformity in the production, whether the product is used as straight purified cotton or as cotton to be nitrated for artificial silk, for collodion film, or for smokeless powder.

The art of dyeing is one of indication. No other industry must be as careful of the purity of the material on which it operates as this one, because our most delicate chemical dyes are but indicators of uniformity. The slightest trace of an impurity present will immediately be indicated by the dye. The slightest variation of the base cotton dyed will indicate in an off-shade in the color produced. All cotton goods presenting uneven shades in the finish are at once rejected from quality consideration. Only through a substitution of the sulphurous acid for the sulphuric can such a uniformity be realized. If the cotton goods industry attempted to dye on the material base which prevailing specifications allow to be nitrated for the making of smokeless powder, it would be compelled to go out of business.

The largest manufacturer of nitro-cellulose photographic film in this country and probably in the world made his films, prior to 1923, from the nitration of cellulose in linters and hull fiber purified in a bleach using calcium hypochlorite and sulphuric acid as a neutralizer. The bleacher of the linters became interested in the sulphurous anti-chlorination and called on the writer to install and put into operation a process designed to correct certain defects which the film manufacturer met with continually in his production, and which defeated all attempts at uniformity and clearness. A series of experiments was conducted over the greater part of a year and results satisfactory in every detail were realized. The installation remained, and the film manufacturer specified that the bleacher should treat all the fiber for these films in a lime chemic bleach anti-chlored with sulphurous acid.

It may be considered satisfactory for the powder makers to rely on the viscosity test for a determination of the quality of the batches passing through, but the viscosity consideration does not count. It merely tells what has happened in the processes that have gone before. It passes along impure lots with the advice that the powder maker must act thus and so because this and that are present in error in the material to be treated, and that this presence just cannot be helped. If the textile dyeing industry were handled in this manner, it would not survive.

Batches of dyed textile fabrics are generally composed of 10,000 pounds of 50,000 yards of cloth each. The value of a batch approximates $10,000.00 for ordinary goods. If a dye plant turns out 50 lots per day, it must take every precaution to prevent non-uniformity, off shade, non-adaptability to later chemical or physical treatment and situational uses, and it cannot afford to make one mistake that would jeopardize this $500,000.00 daily effort.

The powder maker works just the other way about. He allows the errors to creep in and he lives with them, until he has produced a product not in the least uniform in nitration, solubility, stability, speed, and in all the other requisites. But he blends his production and rules by his law of averages. His average is regulated by the low end of his scale.

There is an opportunity for the powder industry—military and commercial—to write is specifications on smokeless powder for cannon with an exaction that the raw material cotton must be kier-treated and bleached along these lines which are considered as highly desirable to follow.

# Small Bore Rifle Shooting

## *The International Match at Bisley, 1931*

By J. S. Hatcher*

FOR some years past it has been the practice of the United States to compete in the International Rifle Matches which are held annually by the International Shooting Union to determine the championship of the world. In 1931 the program was varied, however, by the fact that we did not compete in this world championship match but instead we sent an International Small Bore (or caliber .22) Team to England for a shoulder to shoulder match with the .22 instead of with the usual caliber .30.

An explanation of this change requires us to go a little into the history of rifle shooting as a sport in this country. Most of our readers know that the Government holds the big National Matches at Camp Perry every year, but I doubt if many of them realize the extent to which non-military rifle shooting as a sport, pure and simple, has taken hold in this country in the last ten years.

**The U. S. International Smallbore Team at Bisley, 1931.**

Left to right, standing: C. H. Johnson, Sittler, Johansen, Jacobs, Wilkens, Hamer, Swanson. Sitting: Evans, Randle, Upshaw, Hatcher (Team Captain), Paffe, Sheldon, Adams. Kneeling on ground by telescope: McGarity (Team Adjutant), Renshaw (Team Coach). Mr. Johnson was not a member of the team, but being present at Bisley offered his services as assistant coach.

Rifle shooting of one kind or another has been popular in this country since Colonial days. The early rifle matches were at short distances (about 60 yards) and were shot with the old muzzle-loading rifle from a prone position in which the marksman rested the muzzle of his gun on a solid support and rested his elbows on the ground so that the rifle was held in an extremely steady manner.

The target was a piece of white paper nailed on a charred board. There was a hole cut in the center of the paper for an aiming mark and the object was to strike the center of a cross formed by two intersecting lines drawn on the charred surface with a penknife.

About 1880 with the advent of a really accurate Army rifle, long-range military shooting became very popular and has remained so ever since. Long-range shooting is, however, a game that can be played only with Government or State assistance for it is necessary to have a range over a half-mile long with either an extremely effective back-stop, such as a big hill, or else a lot of waste land beyond the rifle range where the bullets can go without doing any harm. This means usually a Government or State range, as such an establishment is outside the means of the individual shooter or even the average club. Moreover, the cartridges for this military type of shooting cost from 3 to 5 cents each and it is rather expensive for the individual to do much shooting of this kind.

Under the encouragement of the Government, however, military shooting has remained extremely popular and the big shooting events in this country are the National Matches which of late years have been held annually in September at Camp Perry, Ohio.

GREAT BRITAIN is another country which has the same type of military target practice that we do, which includes prone shooting with ranges up to 1000 yards. Most of the other nations of the world confine their military shooting to short ranges, usually 300 meters.

In Great Britain before the war the sport of "miniature" rifle shooting had become very popular. Miniature rifle shooting is the British term for what we call small-bore shooting, which is target shooting with rifles using the rim fire caliber .22 cartridge. The caliber .22 cartridge is one of the most accurate in the world but due to the fact that it has a small bullet, the range and power are very much less than that of a military rifle and it lends itself admirably to indoor shooting. Moreover, the cartridges are extremely inexpensive, the average retail price being about $5.00 for 1000 cartridges.

The fact that no extensive rifle range is necessary, coupled with the cheapness of the ammunition, means that this type of marksmanship can easily flourish without government assistance.

After the World War miniature rifle shooting was revived in Great Britain and several of the British rifle shots introduced it at our National Matches in 1919. Before that time we did not have any gun in this country that was well adapted to such a sport but at the National Matches in 1919, two American-made small-bore rifles appeared on the market although in a rather crude form.

This marked the beginning of small-bore shooting in America. Up to that time the sport of rifle shooting had been fostered by the National Rifle Association of America

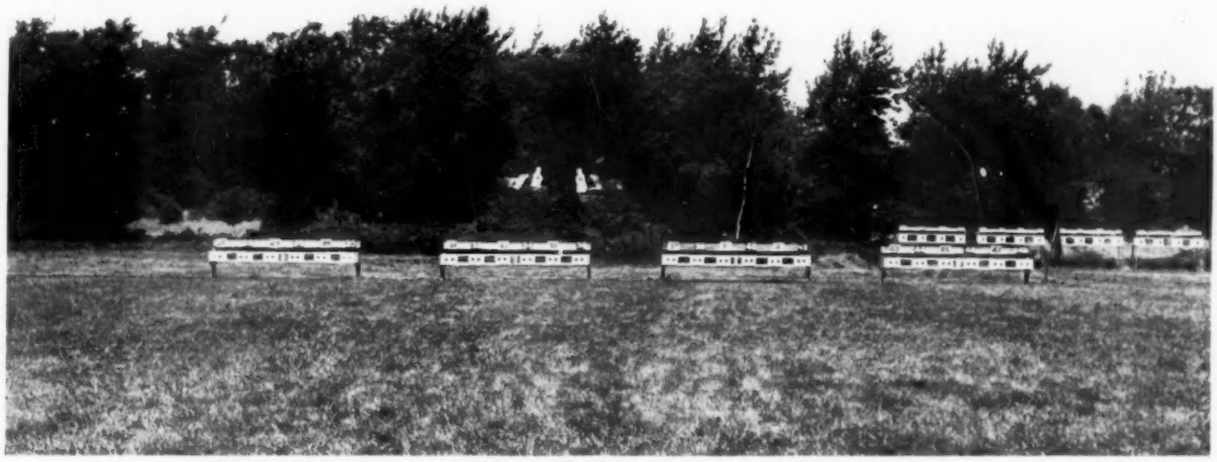
*Team Captain, U. S. International Smallbore Rifle Team, 1931. Chief, Small Arms Division, Manufacturing Service, Office of the Chief of Ordnance. Major, Ordnance Department, U. S. Army.

which consisted of a few thousand members interested in rifle and pistol shooting. With the establishment of the small-bore shooting as a sport in this country, the membership and power of the National Rifle Association started to increase. At the present time this organization has approximately 130,000 small-bore shooters and at the rate at which the sport is growing, it appears that within five more years there will be 500,000 devotees of this type of target practice through the efforts of this splendid organization.

late years and these shocks are due to the frequency with which our best teams have been defeated in International Rifle Matches abroad.

One reason for our inability to win regularly at the International Matches is the fact that the shooting game as played at those matches is entirely different from the kind of shooting that is done in America.

The main shooting organization abroad is the International Shooting Union, and the matches held by that



**The Smallbore Range at Bisley on Which the International Match was Fired.**

The 50-yard and 100-yard target frames in place. The frames each contain six targets. They are loaded up behind the line and are placed in position as soon as the relay stops firing, the old frames being brought in at the same time.

In the old days of big-bore shooting, the rifleman could fire only during the outdoor season, that is the summer. While the small bore also flourishes in the outdoor season with ranges of 50, 100 and 200 yards, perhaps its greatest activity is the indoor shooting which is done by schools, colleges and rifle clubs all over the country during the winter. This indoor or gallery shooting is done at ranges of 50 or 75 feet. This sport is not limited to men, for there are many excellent girls' rifle teams as well as many teams having both men and women as members.

IN this country we have for many years been accustomed to pat ourselves on the back for the excellence of our rifle shooting. We undoubtedly have the most accurate military rifle and ammunition in the world and at Camp Perry with our own particular style of military rifle shooting, in which the prone position predominates, we have been able to shoot increasingly fine scores from year to year.

In fact, there is no doubt that the excellence of our rifles and ammunition, from the standpoint of accuracy and suitability for target shooting, is entirely due to the policy of holding these matches every year to be shot with service rifles. This quickly brings to light any faults with guns or ammunition from a target-shooting standpoint. However, our complacency in regard to our target shooting accomplishments has been subjected to a number of rude shocks in

organization are shot not with a military rifle but with the so-called "free rifle." In this free rifle it is the practice to use set triggers, sometimes called "hair triggers," which are not ordinarily used in this country at all. Then the rifles have a specially shaped stock with adjustable butt plates having large prongs to prevent them from slipping off the shoulder. These rifles are also fitted with palm rests and are made with very heavy barrels. They are the result of years of development in which the object has been to produce the rifle most suitable for obtaining high scores under the system of shooting in use.

They fire in three positions: standing, kneeling and prone, at a distance of 300 meters (328 yards). At this distance they use a target having a 4-inch center ring which counts 10, and other closely spaced rings all the way down to the count of one. On our own 300-yard range at home we use a target which has a central ring 10 inches in diameter which counts five, and the other rings are widely spaced so two shots which differ quite a bit in their distance from the center might still count four.

THE type of rifle used in Europe, or the free rifle, has no counterpart in this country and none of our marksmen is used to this type of rifle shooting unless he deliberately train himself for the International Match, in which case the rifles usually have to be obtained from abroad and re-

made to take our ammunition, all at very great expense.

The International Shooting Union was organized in 1897 and in the first year the French won the match, but after that the Swiss won it every year until the World War caused the matches to be suspended for five years.

In 1913 the matches were held in America at Camp Perry. The Swiss came over here, and while they had to contend with conditions strange to them at Camp Perry where they were in a wet and muddy camp with very poor facilities at that time, they nevertheless beat us in no uncertain way.

However, after the World War we participated in the matches held at Lyons in 1921 and we were the winners. Our winning this match was due almost entirely to the fact that we could shoot the prone position far better than anyone else because it is the prone position which is most used at Camp Perry.

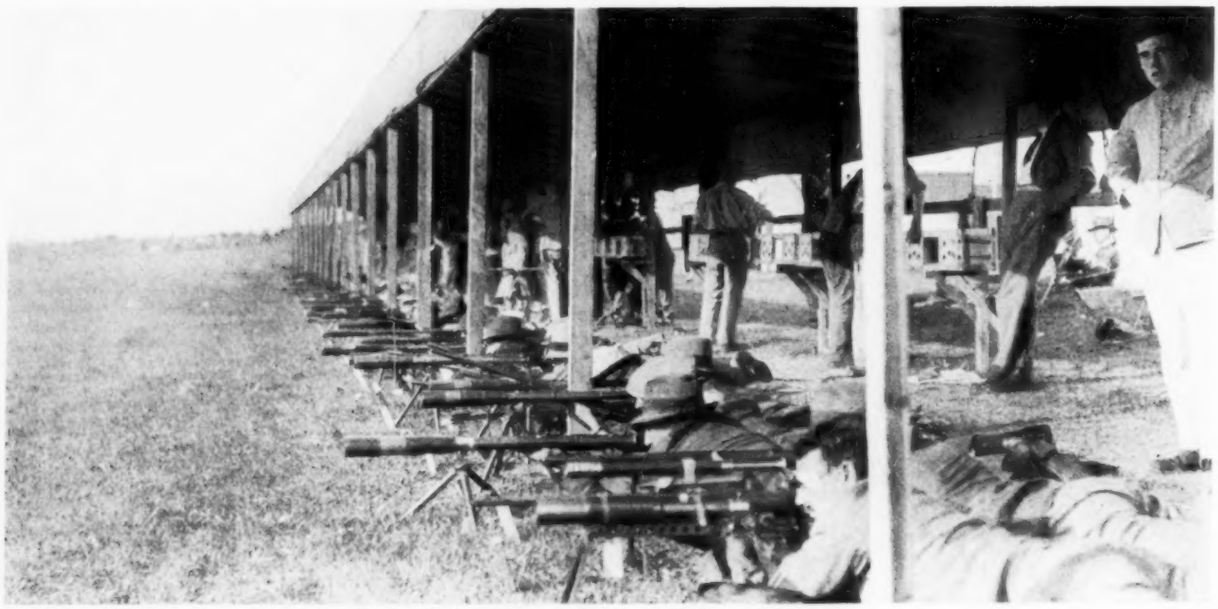
Some of the European competitors were much upset by our use of the rifle sling, which was not familiar to them. They claimed that the use of this sling in the prone position was an unfair advantage and should be barred. They were unable to make such a rule, however, as quite a few of the different nations, notably the Scandinavians and the French who liked to use our own Springfield rifle for target shooting, voted with us to keep the sling in the rules.

The next year, in 1922, the matches were held at Milan and we were again the victors owing to the very large advantage gained in the prone position.

The matches were held in America in 1923 at Camp Perry and no one else sent a team over so that we fired through this course without opponents and were the victors by default.

In 1924 the matches were held at Rheims in connection with the Olympic Games and again we were the winners, though it was to be noted that the Swiss had adopted the sling and that their prone score had greatly improved. Every move of our shooters was watched very closely and our competitors adopted everything they thought to be an improvement over their method.

The results of this move on the part of the Swiss showed up with startling swiftness. In 1925 the matches were held in Switzerland. Our team was entertained with the greatest hospitality, the necessary arrangements to give us a place to practice were made and care was taken that everything was in first-class shape. The Swiss team then proceeded to give us a sound beating at the matches held in St. Gall that year in which the writer of this article participated.



**The Smallbore Firing Range at Bisley in Operation.**

Note the target frames on racks in the shelter. These frames are filled with fresh targets ready to be carried out and placed in position as soon as the relay is finished. These frames are double, with a target in front and a blank card behind both carrying the same number. If a competitor fires on the wrong target, this blank card will show who did it. The competitor is fined one shilling, but is given the value of his shot less one point.

This same bitter dose of medicine was administered to the American team from that time on until 1930, at Antwerp when we were again able to win the World's Championship and bring back the Argentine Trophy to this country.

To accomplish this we were obliged to do just as the Swiss had done and to adopt the equipment that enabled them to win. We could hold our own in the prone position but in the standing and kneeling positions, our rifles are no match for the specially designed set-trigger Martinis with palm rests used by the Swiss, so we went over to Switzerland and bought a number of these rifles and had them rebarrelled to take our own cartridges and then trained our men with them, and so were able to win again.

OUR yearly participation in these International Matches had many excellent effects besides the creation of additional interest in rifle shooting. Not the least of the benefits in this international rifle shooting was the fact that it taught us that some of the foreign nations, notably Switzerland, had ammunition which was more accurate at 300 meters than anything that we ourselves could conveniently obtain.

This discovery resulted in a very careful study of the question of accuracy and in the production of ammunition which was considerably more accurate than anything we had had before. The net result was an increase in our knowledge of how to make ammunition accurately and an over-all increase in the excellence of the ammunition being produced for our service.

Moreover in Switzerland we came in contact with the noncorrosive primer, as the result of which practically all commercial ammunition being made in this country today has primers of this general type instead of the old style which required constant cleaning of the gun barrel to prevent its ruination.

However, we were spending a lot of money and effort on this match and in reviewing the situation it appeared that it would be much better business to spend this money and effort on a game that would appeal to a larger number of Americans and it was thought that rifle shooting in America should be encouraged as much as possible by participation in the International Matches.

There are only a few dozen men in this country who shoot the free rifle at all or who are familiar in the least with the 300 meter shooting game as it is played in the International Shooting Union. What we were up against was the necessity of picking from this handful of candidates a team to defeat the best marksmen of a country where the whole shooting fraternity is intensely interested in just that kind of shooting.

THE small-bore shooting game differs quite a bit from the caliber .30 in many ways. For one thing, a great deal of shooting is of the gallery type, done indoors during the winter season, which is not possible with the .30 military rifle and full charge ammunition.

In gallery shooting with the caliber .22 the standing, kneeling, sitting and prone positions are used, but in the outdoor shooting the only position used is the prone.

With the caliber .22 the telescopic sight is very popular and there are many matches in which this sight is used. The use of telescopic sights conduces to extremely close holding as any little error shows up, magnified many times by the telescope.

It is generally believed at the present time among small-bore shots that the caliber .22 shooter is the best and steadiest "holder" in the world and that as a class the small-bore shots hold more steadily than the large-bore shooters.

There are many reasons why this might be so. In caliber .22 shooting there is no big explosion or recoil when the trigger is pulled. The noise of the little .22 cartridge is hardly audible and the recoil is practically negligible, especially with the heavy barrels which are used on modern guns.

It is contended by the small-bore shooters that the average excellent military shot is not a steady enough holder to be a serious competitor to the present small-bore rifleman. Whether or not this contention is true, the fact remains that no strictly military shot made the team last year, though Dr. Swanson, of Minneapolis, a small-bore shot who has done military shooting, was on the team.

Our 1931 team comprised 12 shooting members and three officials, and all shooting members of this team were civilians. This complete shut-out of our military and naval forces is rather significant and if this happens several more times it may result in some very critical self-analysis by our military and naval marksmen and instructors.

ON June 24, 1931, the team sailed from New York on the steamship PRESIDENT ROOSEVELT for the first shoulder-to-shoulder caliber .22 match between Great Britain and America.

For many years we have been having annual "postal" matches between Great Britain, Canada, Australia, New Zealand and ourselves. This match is called the Lord Dewar Match and is fired by each country on its own home range by a team of twenty men. After the firing the scores are compared by letter or by cable. In the last few years we have been constantly winning this match so that our people somehow got the idea it would be easy to beat the British in a shoulder-to-shoulder match. However, there is quite a difference between a cable match, where one team fires in one country and another in another country, than a shoulder-to-shoulder match where both teams are together. In the first case the conditions are bound to be different, that is, in one country there may be wind and in another there may be rain, so that there is some element that enters into the decision other than the skill of the contestants. This year we arranged to shoot the match on the big English rifle range at Bisley just outside of London.

The first few days at Bisley were spent in shooting in the individual matches to gain practice for the big International Match to come toward the end of the week. There were six individual matches open to us and in five of these an American tied for first place only to be finally beaten out by a Britisher who made the same score but was adjudged the victor because he had a group that gave the advantage when the rules for deciding ties were applied.

However in one of the individual matches, the Grand Aggregate, which is perhaps the most important of all, Dr. Swanson was the winner with a score of 1392 and Mr. Johansen was second with a score of 1387, both breaking the former British record of 1386.

ON July 10th, the big match was fired and though the British fully expected to be beaten because of the regularity in which we had been able to beat them in the Dewar Match, they emerged from this shoulder-to-shoulder match the winner by two points, their score being 3927 as against 3925 for us.

The performance of the British in the big team match was really magnificent and the way all our individual scores were tied and finally outranked was another indication that in this small-bore game the British are second to none.

It is intended to hold another International shoulder-to-shoulder small-bore match at Bisley in 1932 and it is hoped that some of the other European nations may be there also.

Besides the Small-Bore International Match there will be a big-bore match in 1932. We will probably participate in this big-bore match because it will be held in this country by the International Shooting Union. It has long been the custom in Olympic years for this match to be held in the country which holds the Olympic Games and as these games are to be held at Los Angeles in 1932, that means that the United States will be the host for the shooters of the International Shooting Union. The caliber .30 free rifle match will be held at Camp Perry sometime in September, 1932.

# Possibilities of the "Air Tank"

## *Part V: Sky Raiders*

By Fred. H. Wagner*

BEFORE proceeding with my remarks, it is my pleasant duty to call attention to the arrival of the amphibious tank in England, thus realizing one of General Fuller's desires, providing this tank, invented by Captain Liddell Hart, will measure up to the inventor's expectations. From a description of this tank I quote: "On land this amphibious monster can make more than forty miles an hour, can cross ditches more than a yard wide, and as a mere matter of course can climb slopes of 30 degrees, and even slopes of 45 degrees if not too long. In the water this amphibious tank forges ahead, driven by a propeller at the stern and steered by a tiller. Only the machine-gun tower and part of the bridge are visible, offering a target very difficult to hit. It then climbs up on *terra firma,* mounting the shore anywhere, whether at a steep point or through mud and waterside weeds. The total weight is two and one-half tons, and the steel armor with which it is covered is more than one-third of an inch thick and at 150 yards can resist the heaviest machine-gun fire."

The speed of this new war monster in the water is not given, nor are the "heaviest machine guns" the only weapons which it will encounter while slowly crossing a stream and mounting the land. More of this new implement of warfare later.

I now turn my attention to a subject which, while not strictly identified with tanks, is nevertheless a vital problem in the general discussion which I have undertaken in this series. The airplane and the tank are the two much discussed factors in the new theories of national defense and my thesis would not be complete without due consideration to "Sky Raiders."

IT was not many years after the Wright brothers had succeeded, in 1903, in making a large box-kite structure hop and fly a few hundred feet at Kitty Hawk, before their idea had developed into an obsession in all civilized nations, and all the principal European powers were soon thereafter engaged in a course of extensive airplane developmental experiments, principally for military use. Almost four years later, or in 1907, the office of our Chief Signal Officer had incorporated an aeronautical division within its folds and, through the assistance of the Wright brothers and Glen Curtiss, valuable development progressed, but funds were lacking to make this research and development of any value in warfare. In 1910, however, the French had a few airplanes in the annual maneuvers for observation purposes, and in 1912 military aviation was regularly organized in the French service. Germany started research work in 1910, and in 1911 airplanes took part in the army maneuvers. In 1912 the British created an air department, the maneuvers of that year seeing a few British planes in the air. The Royal Flying Corps was organized in 1913, and from the results obtained during the maneuvers it soon became evident that observation from the air would play an important role in any future war.

The first military use of the airplane in actual war was during the Italo-Turkish War, 1911-1912, when the Italian Army had at its disposal some 50-horsepower single-seater planes for observation purposes. These planes were capable of reaching an attitude of only about 3,300 feet, nevertheless they obtained valuable information regarding the disposition and movements of the Turkish troops. For example, what was intended to be a surprise attack by the Turks on the Italians at Sciara-Sciatt in October 1911 developed into a complete failure, due to the reconnaissance of the Italian planes. Again, in December, the Italians gained a complete victory over the Turkish forces at Ain Zara, due to absolute knowledge of the Turk dispositions obtained by the air forces, and while the battle progressed the Italian command was informed of all its phases. The time and direction of the Turkish retreat was also obtained in this manner; with the result that all major resistance by the Turks was broken down completely.

This was followed by the Balkan Wars of 1912 and 1913, but neither the Balkan allies nor the Turks possessed an air force; planes were purchased, but the proper personnel was lacking and the results obtained amounted to absolutely nothing.

In spite of the success obtained by the Italian air force, little attention was paid to the possibilities of the airplane by some of the military leaders, especially the Germans, but this condition was soon to be changed—the World War was at our door-steps. At the outbreak of the war every airplane available among the belligerents was commandeered, and production was started in all the countries at war. The skeptics must have become convinced of their errors in a very short time, for with the beginning of the war air observation became most important. While the Germans still lagged behind, the British and French depended almost entirely upon air reconnaissance for their information regarding the enemy. This lack of appreciation was to cost the Germans dearly in the early part of the war, or during the advance through Belgium and Northern France when, had they taken advantage of the information provided by their airmen, it would have been possible entirely to destroy the entire British Expeditionary Force, under French, as well as the French Vth. Army under Lanrezac.

By referring to the two maps[1] (Figs. 1 and 2) of this situation, or the one of August 23 and that of August 24, 1914, this condition becomes plain. It is seen that von Gallwitz was still besieging Namur, while Lanrezac was in position southwest of Namur, at the juncture of the Sambre and Meuse, from opposite Dinant to the northeast

*Consulting Engineer. The Bartlett Hayward Company, Baltimore, Md. Colonel, Ordnance Reserve, U. S. Army.

1. Observation Aviation. Air Corps Tactical School. Langley Field.

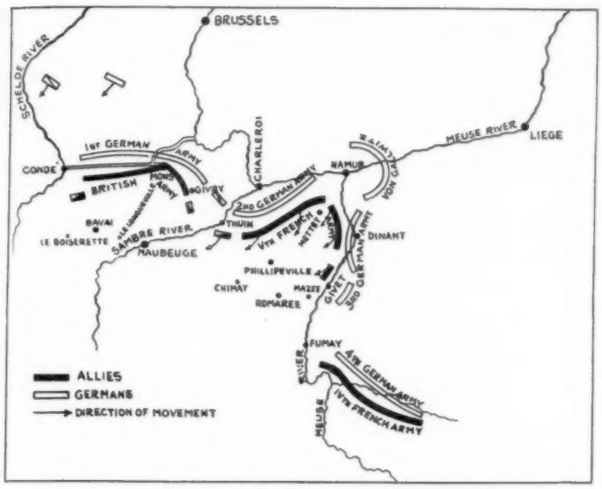



**Fig. 1. Situation Map, Belgium and Northern France, at 9:00 A. M. on August 23, 1914.**

of Mettet and southwest to near Thuin. The German 2nd Army, commanded by von Bulow, was across the Sambre at Charleroi, where he forced Lanrezac to retreat for a distance of 4 miles on the morning of the 23rd; in the afternoon of the same day the German 3rd Army, under von Hausen, crossed the Meuse near Dinant. Lanrezac started his withdrawal about 10:00 o'clock on the morning of the 23rd, and a general withdrawal was ordered at 9:00 that night.

In the meantime, the British Force held a line from Givry to Mons and thence along the Condé-Mons Canal, with the German 1st Army, under von Kluck, in front of it. Word was received by Sir John French at about 11:00 o'clock on the night of the 23rd that Lanrezac was withdrawing.

The air forces of the German 3rd Army reported at 10:00 A. M. on the 23rd that Lanrezac was beginning to withdraw in a southwesterly direction. This was answered by the Germans in ordering one division stationed near Givet to intercept the French movement by crossing the Meuse near Fumay, while it was further intended that as soon as the Meuse was crossed the main body would proceed toward Phillipeville and Romaree in pursuit. Unfortunately for the German intentions, this movement was held up, because the German 2nd Army was calling for assistance in a coördinated attack which was to take place on the 24th, von Bulow being under the impression that Lanrezac was still occupying his position in force south of the Meuse with his right flank north of Mettet. It was therefore requested that the 3rd Army assist the 2nd by making an attack in the direction east to west. In spite of the intelligence given on the 23rd of Lanrezac's withdrawal, orders were given to advance the greater portion of the German Army toward the west.

During this entire time Lanrezac was withdrawing rapidly to the southwest, with the consequence that on the morning of the 24th he occupied the general line Mazee-Chimay and to the northwest toward Maubeuge, his left flank being about 15 miles in the rear of the British right. At 4:00 A. M. on the 24th the British began to withdraw, von Kluck pressing them closely, and at 9:00 that night the British were on the line La Longueville-Bavai-La Boiserette. The whole affair consequently ended in a blow in the air; the routes of advance converged and the leading units of the German armies became so mixed up that it was possible for Lanrezac to withdraw during the night almost without interruption. Had von Bulow's request been denied by von Hausen, had the latter placed more faith in the information supplied by his own air force, and had he carried out his original plan, the British Army and the French Vth Army would in all probability have ceased to exist. The road to Paris would have been an open way, the Allies would have been definitely defeated, there would have been no battle of the Marne, and Germany would have remained in the field victorious.

IT has been stated often that the March offensive of 1918 (see Part II of this series) was a surprise, hence its success. This, however, is not true, as is witnessed by Marshal Haig who in his Dispatches,[2] referring to this offensive, says it was foreseen and that he even recognized the point of attack. Quoting Haig: "Constant air reconnaissances over the enemy lines showed that rail and road communications were being improved and ammunition and supply dumps increased along the whole front from Flanders to the Oise. By the end of February, 1918, these preparations had become very marked opposite the front held by the Third and Fifth British Armies, and I considered it probable that the enemy would make his initial effort from the Sensee River southwards. . . . On the 19th of March my Intelligence Department reported that the final stages of the enemy's preparations on the Arras-St. Quentin front were approaching completion, and that from the information obtained it was probable that the actual attack would be launched on the 20th or 21st March. On our own side, our dispositions to meet the expected offensive were as complete as the time and troops available could make them."

This statement speaks highly for air reconnaissance, but very poorly for the "year of tank victory," since the British had 320 Mark IV and 50 Medium Mark A (whippet) tanks at their disposal to assist in repelling this advance.

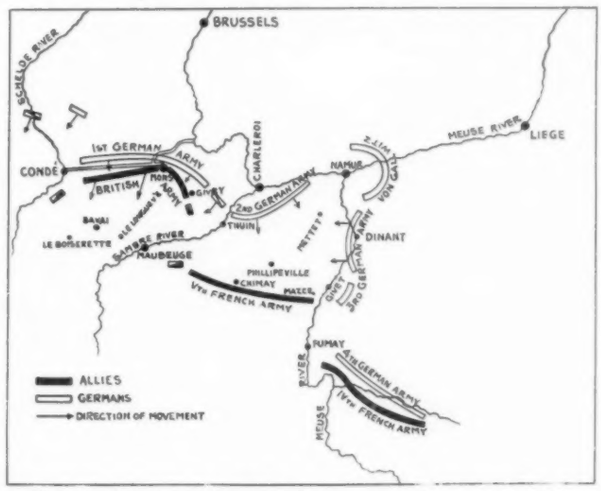



**Fig. 2. Situation Map at 4:00 A. M. on August 24, 1914.**

2. Sir Douglas Haig's Dispatches, by Lt. Col. J. H. Boraston. E. P. Dutton & Co., New York.

The Great War had progressed only a few months when the service rendered by these "eyes" of the army received the recognition they so richly deserved. This was true not only in the armies of the Entente, but the Central Powers also began to recognize their efficacy. British airmen discovered von Kluck's turn to the southeast of Paris during the early days of September; in October German aviators reported an Allied movement on the Aisne, and the German counter-movement, which led to the "race for the sea," was discovered by British airmen. Allied aviators made it possible for the Allies to follow the movements of German reinforcements between Arras and Nieuport, and thus gave them an opportunity to strengthen their own lines. Aviators warned the British of the movement of Turkish forces across the desert for an attack on the Suez Canal. The weakness of the Russian positions at the Masurian lakes was discovered for von Hindenburg by aviators. Japan obtained information regarding conditions in the fortress at Tsingtau through aviators. This is but a fragment of the services rendered by these daring airmen, but it will serve to call attention to their inestimable value.

THE Great War made the world really air-minded, and development of aircraft assumed new proportions. While this new development when applied to the armies was intended to be the "eyes" of the latter, it was but a short time before these intrepid airmen assumed other duties. Air fights, amazing to the man on the ground, took place in the clouds, being precipitated by one side sending up planes with the object of preventing the planes of the other side from making use of these "eyes." This was followed by bombing expeditions, the object of which was the destruction of military works, arsenals, storage dumps and rail heads.

Due to this varied work, the airplane soon developed into several distinct types, and today we have observation planes, still the eyes of the army, which have a speed of from 100 to 130 miles an hour; they are usually two-seaters and are armed with a machine gun fore and aft. Pursuit planes, which are faster than those employed for observation, some having a speed as high as 225 miles an hour with a service ceiling of about 28,000 feet. Pursuit planes are designed to out-maneuver and shoot down or destroy enemy aircraft, hence they are usually armed with two machine guns forward of the pilot, these guns being synchronized with the propellers, shooting past the revolving blades of the latter. Then come the attack planes with a speed of between 130 and 185 miles an hour usually equipped with six machine guns and carrying ten or twelve fragmentation bombs. Finally, we have the giant bombardment planes carrying heavy bombs intended for the destruction of ground objectives. These planes have a speed of between 120 and 130 miles an hour with a ceiling of about 16,000 to 18,000 feet; they are twin-motored and are armed with machine guns for warding off the attack of pursuit planes. Besides these, we have cargo and ambulance planes as well as others intended only for training purposes.

The duty of observation was legitimate work, as was also the destruction of fortified bases, fortresses, communications, ammunition dumps, etc., when ever this was possible, hence it is readily seen that the airplane, from the very beginning of the war, became an *important arm of the military service.* To these services must be added a third, or one introduced by the Central Powers; one which contravened all rules of the Hague Convention, but which is often proposed by present-day writers on military subjects, namely, the destruction of civilian property and life for the purposes of intimidation.

UNFORTUNATELY, modern military thought among civilized nations has been centered to a large extent on this subject, i. e., the use of the airplane as a means of wrecking the "nerve centers" of an enemy nation by the dropping of explosives, or incendiary and gas bombs on cities and towns, whether military bases or not. The idea is focused on bringing the civilian to his knees and making him sue for peace. The chivalry which was supposed to exist among the peoples of all civilized nations, or at least the laws which are supposed to govern warfare, thus seem to have become a dead letter in modern minds since the World War developed these new means for creating horror. And horrors are to be improved upon and employed against women and children, as well as civilian men, should the world be so unfortunate as to witness another war.

Publicly one seldom hears of plans which contemplate bombing military areas from the skies, although these plans are prepared, but when airplanes are mentioned the statement usually follows that the bombing of a civilian population is the quickest and surest way for bringing a war to a successful issue. Whether this is propaganda for the air force or whether it is meant to be what is really intended the future alone can decide, but that it has been used for propaganda purposes will soon be seen.

In our own Army Ordnance (Vol. X, No. 59, page 311) we find the following words: "The importance which aircraft will assume in future military operations is now universally understood and accepted. It is available to small as well as to large countries; can act simultaneously with the declaration of hostilities and may immediately produce such destruction in *poorly defended cities* as to break down civil morale and bring about a decisive victory before other forces can become effective." This means the murder of women and children, and only a few years ago we were condemning the Central Powers for their "hunnish" actions in precisely the same case.

We protested strongly during the Washington Arms Conference against the use of poison gas, but four years later we rejected a treaty outlawing its use. However, this treaty is binding upon Great Britain, Irish Free State, France, Germany, Austria, Belgium, Denmark, Finland, Italy, The Netherlands, Sweden, Russia, Jugo-Slavia, Canada, South Africa, Australia, New Zealand, Liberia, Egypt, Persia, Turkey, China and Venezuela. On July 25, 1931, our daily papers published "the army has perfected a system of wiping out entire regiments and *populations* by means of spraying mustard gas—the most deadly weapon yet devised for modern warfare—from airplanes in liquid form, but upon striking the air quickly vaporizes, forming a gaseous substance that penetrates the lungs and clothing with ease. . . . It is not the *intention* of this country ever to use it against cities, but rather to confine its operation to the actual fighting front." This statement is rather poorly expressed, but its meaning is clear, and it furnishes an additional reason for providing adequate aircraft defense, for we do not know

whether any prospective enemy will be so altruistic as not to *intend* using similar poisons against the *civil population*.

As far as mustard gas is concerned, however, it need not be feared by the cities as much as high-explosive shells. Should an airplane spray mustard gas in a liquid form over a city, or should bombs containing it be dropped over a city, the danger to the inhabitants would be in great measure localized due to the protection furnished by surrounding buildings, and but a few citizens in the immediate vicinity would be affected. Again, should this chemical reach the ground it can be neutralized by counter measures. Besides this, it is highly questionable if an enemy would waste chemicals on a city when a greater effect could be produced by spraying it on troops out in the open; but here again means have been developed for protecting the soldier. Under these conditions all means must be employed to ward off the attack of the bomber with his high-explosive "eggs."

Such employment of an air force is brought to a climax of expression by Capt. F. Liddell Hart, a prolific writer of the present day on military subjects, who says: "Every modern industrial nation has its vitals; in one case it may be essential mining areas, in another manufacturing districts, a third may be dependent on overseas trade coming into its ports, a fourth so highly centralized that its capital is the real as well as the nominal heart of its life. . . . But the air has introduced a third dimension into warfare, and with the advent of the airplane, new and boundless possibilities are introduced. . . . Aircraft enables us to jump over the army which shields the enemy government, industry and *people,* and so strike direct and immediately at the seat of opposing will and policy. A nation's nerve system, no longer covered by the flesh of its troops, is now laid bare to attack, and, like the human nerves, the progress of civilization has rendered it far more sensitive than in earlier and more primitive times. . . . Imagine for a moment that, of two centralized industrial nations at war, one possesses a superior air force, the other a superior army. Provided that the blow be sufficiently swift and powerful, there is no reason why, within a few hours, or at most days from the commencement of hostilities, the *nerve system* of the country inferior in air power should not be paralyzed. . . . Nor can it do any harm for our politicians and people to realize the unquestionable, if unpalatable fact that the existence of this country (Great Britain) is dependent upon the good will of France, the supreme air and submarine power, commanding both the vital centers of England. . . ."

This statement comes from a citizen of a country which only a few years ago declaimed against the horrors of air raids. It is excellent ammunition to place in the hands of our pacifists as well as our disarmament proponents and "peace at any price" citizenry headed by one of our largest church bodies in America. I do not mean to be misunderstood, or to imply that I am taking the Christian doctrine to task in this statement, but rather some of the exponents of this doctrine who have arrogated unto themselves divine prerogatives while living in the clouds and floating on a sea of fallacious thought which believes that should we be deprived of the means for defending ourselves there would be no attack on us by other more benighted peoples. The Christian church has existed for almost 2,000 years, but during that period there is no record of it having prevented wars, but to the contrary, it brought about some of the most brutal wars of history. Fortunately progress has removed the possibility of this occurring again from these members of the Church, and instead of consorting with revolutionists who would overthrow all government, the Churches should "stop, look and listen," and remember what happened to their confreres in Russia when the revolutionists got the upper hand.

LET us look for a few moments on the results obtained by air raids on "nerve centers" during the Great War and see if these are what Captain Hart supposes.

The Zeppelin campaign started out with the purpose of destroying works of military value, such as arsenals and troop concentration areas, but it was not long before the desire to inspire fear in the civilian population (nerve center) became an obsession with the Central Powers, hoping that such action would weaken the Allies in the field. Let us examine the results of this campaign of horror and learn if these hopes were realized.

In the early part of the war, or in 1914, the Germans made but little use of the Zeppelins, but placed their reliance on "Taubes" and "Aviatiks." Here they were up against the cleverer pilots and better planes possessed by the French, whose aviation was not, however, properly organized at the time to engage in warfare. The British organized a Flying Corps which, after careful training and some experience, could hold its own with anything the Germans had to offer. The military wing of the British was employed principally for scouting and artillery observation, while the naval wing was engaged in bombing and raiding, but very few encounters between individual planes had as yet taken place as far as the British were concerned. Garros and Pégoud, of the French air force, however, performed several brilliant feats during these early days. The naval branch of the British, operating out of Dunkirk, proved to be a veritable terror to the Germans and, besides the raids these airmen made on military bases in Belgium, they carried out some very long-distance flights when bombs were dropped on the Zeppelin sheds located at Dusseldorf and Lake Constance. Another feat to their credit was the flight of a squadron of seaplanes which traversed the North Sea and dropped war eggs on the warships and the docks at Cuxhaven.

Paris saw its first air raid on August 30, 1914, when five bombs were dropped on the city, with the result that two women were injured and many windows were shattered. The next day saw three more bombs dropped without doing any material damage. On September 4 two bombs were dropped in the Avenue de'l Opera, but no great damage resulted. This was answered by the Allies when they dropped several bombs at Cologne where a large part of the military railway station was destroyed. December saw French airplanes bombing the railway station and barracks at Metz, a reprisal for a German bombardment of Nancy.

The war was now carried home to England, and on January 19, 1915, a German airship sailed across the North Sea and paid a visit to the coast towns of Norfolk Considerable property damage was done near King's Lynn and Sandringham; it was also reported that a boy and a woman were killed in King's Lynn, and that at Yarmouth one man and one woman met death while three other civilians were injured. Reports were to the effect that a dozen bombs were dropped in several other towns in this vicinity.

February 20 saw a Zeppelin over Colchester, while in April the Tyne and the Eastern counties of England witnessed raids which caused more serious loss of life, the greater portion of those killed having again been women and children. May witnessed a visit to Southend and Ramsgate, while June 1 saw the first bombing of London, and three days later the East coast was raided with twenty-four killed and forty injured. On June 15 two Zeppelins visited the Northeast coast, but were driven off. Two more passed along the East coast on August 12, when four men and two women were killed, while three men, eleven women and nine children were injured.

Several German Taubes also crossed the North Sea with the intention of raiding the English coast, but they were destroyed by British airplanes off the mouth of the Thames. September 7 and 8 saw an attack on London between 10 and 11 o'clock at night. It was reported that one bomb was dropped in a hospital district, but little material damage was done. October witnessed another raid on London and the surrounding district, when fifty-five were killed and one hundred and fifteen were injured.

These raids did not serve any military object, nearly all the killed and injured having been civilians, but they did increase the ill feeling against the Germans.

ACROSS the Channel we find a raid of 34 British planes on Ostend and Zeebrugge on February 12. This was repeated on the 16th and resulted in serious damage to the German submarine base. On April 2 Hoboken and Zeebrugge were bombed by the British, while the French paid their attention to the railroad stations at Muhlheim and Nuremburg. The bombardment of Zeebrugge was repeated by the British on the 8th, and on the 11th the French bombarded the railway station and an industrial plant at Bruges. April 19 saw the railway station at Strassburg the objective of a French airship, while French airplanes paid their attention to fodder stores at Mannheim. On the 21st Mannheim and Muhlheim were again bombed, and on the 28th Friederichshafen, the home of the Zeppelins, and Leopoldshöhe received a visit from the French, and on the 30th the railway station at Valenciennes received its share of strafing. The French bombed the headquarters of the Duke of Wurtemburg on May 3, while on the 11th the German airmen attacked St. Denis and Paris, and on the 26th air bombing destroyed portions of the chemical plants at Ludwigshafen. June 14 saw another bombardment of Nancy by the Germans.

During this year, 1915, the raids all took place on very dark nights, and up to this time no means had been devised effectively to ward off these horrors. Several Zeppelins were accidently destroyed during the first months of the war, while several more met their fate in their hangars, but none had been successfully attacked in the air. Suddenly the Allies were heartened when on June 7 Lieutenant Warneford, of the British Flying Force, met a Zeppelin in Belgium and sent it to earth in flames; unfortunately the hero of this exploit did not live long to enjoy his honor. He crashed in an accident near Paris and was killed.

The month of February, 1915, saw the L-3 and the L-4, two of the largest Zeppelins, wrecked during snowstorms off the Danish coast; a snow layer only a tenth of an inch thick was sufficient to bring down a Zeppelin. In March the L-8 met with difficulties near Tirlemont and became a wreck. April saw a Zeppelin fall into the Adriatic, while in May another broke loose near Koenigsberg and disappeared.

Aerial scouting and spotting for the artillery continually became of greater importance, and this called for an ever increasing number of pilots and observers, while the speed and efficiency of the Allied planes also increased rapidly. Air fights now also became almost of daily occurrence with corresponding casualties. The Allies at this time had the ascendency over the Germans, but the appearance of the powerful German "Fokker" towards the end of 1915 threatened to dissolve this supremacy. The Allied losses were very heavy during this period, which also saw the death of Pégoud, the inventor of "looping," while Immelmann and Boelke became German air heroes.

On January 20, 1916, a Zeppelin dropped ten bombs on Paris proper, and fifteen were dropped near the fortifications, resulting in 24 civilians killed and 30 injured, with 15 houses damaged. Nearly all the killed and injured were women and children. Several days later Paris was again bombed, but little damage resulted.

It was not until January 23, 1916, that further raids were attempted over England, and on this date several bombs were dropped on Dover. On January 31 a raid was made in the Midlands, visiting Norfolk, Licolnshire, Derbyshire, Staffordshire, Leicestershire and Suffolk; nearly two hundred people were killed and many injured. One of these seven raiders, the L-19, was destroyed on its homeward journey.

ON March 5 the Zeppelins raided the east coast of Kent, where a number of civilians were killed or injured. The last night of March witnessed three successive raids which resulted in heavy casualties; one of the raiders, the L-20, came down in the Thames, off Sheerness, and its crew was captured. On April 1 Zeppelins dropped some ninety bombs over the eastern counties of England, and on May 2 the largest number of Zeppelins in one flight up to that time made another raid, but this resulted in only thirty-six casualties and the material damage done was slight. During this month another Zeppelin was lost during its homeward journey. The end of July saw two more raids and August three, the northeast coast having been the objective.

August 25 witnessed renewed raiding activity, and eight civilians were killed and thirty-six injured. On September 2 thirteen Zeppelins passed over London and its suburbs, one of them being shot down near the city; the damage done was two killed and eleven injured. A raid by a squadron of Zeppelins on September 23 netted thirty persons killed and one hundred and ten injured, and numerous fires resulted in London. This raid was, however, dearly paid for since two of the raiders were brought down in flames, the crew of one being killed outright while that of the other was captured and no military damage was done.

On September 26 the south, east and northeast coast as far north as the Midlands was the district selected for the raid, industrial centers having been declared to be the object of attack, but no damage of military importance resulted. On October 1 ten Zeppelins appeared, but the antiaircraft gun fire, which had been developed by that time, completely baffled them and one was sent to earth in flames. The next field of attack was again the northeast coast on November

27, and two were brought down ablaze. On March 17, 1917, another Zeppelin came to earth in flames near Compiegne.

As a weapon of war the Zeppelins proved rather a failure, and as scouts they were greatly outclassed by airplanes. In the beginning the raiders dropped bombs which were not very effective, but later both the size and the quality increased, with the consequence that quite a number of people were killed and injured, but the material damage was not what had been expected. It is not quite understandable why no one had thought of any proper means for dealing with sky raiders until late in 1916, when the effective defense, composed of antiaircraft guns, searchlights and counter air attacks made air raids rather unremunerative. Zeppelin disasters rapidly followed each other and the early part of 1917 saw their abandonment for this purpose, large airplanes supplanting them.

By January 1, 1918, Germany had commissioned fifty-three Zeppelins, of which thirty-five were destroyed; two were so badly damaged that they were permanently placed out of commission, and two were missing. Germany also possessed thirteen airships of the "Schutte-Lanz," the "Gross" and the "Parseval" types, of which six were destroyed. Of the fourteen Zeppelins remaining towards the end of the war, ten were used for observation purposes in the North Sea, while the other four were used for training.

The peace required Germany to deliver one of her latest Zeppelins to France, and the DIXMUDE was selected. When turning this airship over, the Germans called attention to her light construction, but this did not seem to bother the new owners in any manner. They did not have much service out of her, for she was soon destroyed. The DIXMUDE had been intended by the German command for quite a different service, had the armistice not altered conditions. This ship was one of the last constructed during the war, and she was built for the express purpose of crossing the Atlantic so that a few "war eggs" might be dropped on the city of New York, thus bringing some of the air horrors home to our people. This was, fortunately, negatived by the armistice.

From the Fall of 1917 and through the winter of 1917-18 it became usual for the citizens of London on every moonlight night to be awakened by the ringing of alarm bells, the blowing of sirens and the whistles of the police. They awoke to see the hasty clearing of the streets, while the defiant notes of the antiaircraft guns struck the ear in wild crashes as they put up a barrage against the sky raiders, or the German Gothes which were now employed to "destroy the nerve centers." This was followed by the rushing sound of the fire-engines and ambulances, thus ushering in another night of horror.

Did these attacks on the nerve centers of Great Britain effect the object sought? The answer is NO. But they did give England the best recruiting sergeant produced by the war.

NOW let us examine this new implement of warfare and try to determine whether its new name, or the "dominant factor in warfare," as it was christened during the air maneuvers of last May, really belongs to it. There is no question but that aircraft, especially airplanes, proved their great utility during the recent war, but the success obtained has resulted in the presentation of much loose talk as to what they will do in the next war. There is also no question that the development of any air force does and will depend on civil aviation, and I think I may safely say that the airplane of today will be almost a unique relic ten years from now. Consequently any large stock of these "birds" provided at present, or any beyond our immediate needs, will be worth about ten cents on the dollar in any war fought a decade from now, providing this war is to be fought with another highly industrialized nation.

We are told that aircraft are not restricted by terrestial objects, such as are met with by any army on land or by a fleet at sea; that they can avoid armies and fleets and strike from the skies, or from a *direction which cannot be guarded;* that it is this power which enables them to penetrate any normal system of defence, thus permitting them to strike at the army or fleet without first *breaking through* their circumferences. If this means anything, it means an attack on the "nerve centers," but there are certainly limitations in the airplane itself which places prohibition on some of these movements. The airplane is limited in its carrying power, hence it is highly questionable as to whether it can bring sufficient weight against any city protected by a *proper system* of air defense, which latter can hurl tons of destruction into the skies while the skies are dropping pounds on the city.

The airplane is also limited in its radius of action. Its presence in the air is measured by hours, and not days; it is ravenous in its appetite and must be fed at regular intervals. This demands an operating base, or a place where it can be refueled; this base may be an airplane carrier at sea, or it may be a region on the land *protected by human flesh* somewhere in the rear of the field of action. If there ever was a point of attack where the *tank* might possibly justify some of the exhorbitant claims made for it, this base might take first place, providing the tank can penetrate or outflank the line of human flesh and then destroy this base, for without the latter the airplane is only a useless conglomeration of materials. At sea it is presumed that the enemy also possesses a navy, but this navy may have been defeated, in which case the *submarine* must be relied upon to destroy this floating base. Is the submarine incapable of doing this? I hardly think so. Furthermore this vessel is also subject to improvements during the next decade. A submarine may be thus sacrificed by the enemy, but one torpedo striking a vulnerable portion of the floating base will do far more material damage than the lost submarine could possibly pay for. Hence these limitations may be summed up in a few words. Airplanes are unable to offer protection against shells fired from the ground or ships, and they are compelled to return to their base for refueling and refitting.

WE have heard and read a great deal about how airplanes demolished obsolete vessels of the Navy, worn-out airplanes sitting on the ground, and how in another case they demolished a bridge which was to be removed in any event. No one will ever dispute the fact that a hit by a modern bomb dropped from the skies will cause immense damage, as was done to the discarded ships, airplanes and bridge. The airplanes appeared in the sky, sailed across the objects to be destroyed, dropped their eggs, and then sped on home. Would this same result have been obtained

if the decks of the ships had been able to spout out a crashing barrage from antiaircraft guns, or had the resting airplanes and bridge been protected by several batteries of antiaircraft guns? Would the bombs have been aimed so accurately? I will leave the answer to you.

Later history does not, however, seem to make this entirely necessary, as witness the abortive attempt to bomb the old hulk Mount Shasta last August. On the first day of this attempt, due to "poor visibility," the hulk could not even be located, and on the second day, although it was found, the dropping of some 8,000 pounds of bombs resulted in only two hits, resulting in giving the ship a "slight list to starboard," and she was finally sunk by direct gunfire.

The limitations mentioned above cannot be denied, hence the propaganda so prevalent as to what the airplane will do in the next war had best be somewhat toned down, because there is no evidence except imagination to bolster up these wild and misleading statements.

I stated above that civil aviation must be looked to for the development of the airplane of the future, and the progress of any future war will no doubt bring about the desire to strike at the "nerve centers," and here I wish to quote General Fuller[3] again, or "Assuming, however, that such a form of war (attacking nerve centers) is decided on, then air attacks on capital and other cities are likely to be heavy, and as neutral powers may support the attacked, the attacker must be supremely powerful in the air. In such operations it is no longer a question of a one-power, but a many-power standard, and a large reserve to make good casualties. This introduces the problem of civil aviation. Without civil aviation there can be no extensive production of machines immediately after the outbreak of war, and today civil aviation is in its infancy, and quite probably will remain in a subsidized condition until a radical improvement in aero-engines takes place. We may dream of flying taxi-cabs and aerial tramp steamers, that is, of passenger airplanes and cargo airships, moving in all directions through the air. Though such dreams are not irrational, they are, in my opinion, unreasonable as long as petrol and the internal combustion engine are used, for the *cost per ton-mile* is so vastly greater than the cost on sea and land as gravely to restrict this traffic. From this fact alone the general deduction is that no nation in the near future will be in a position to place all, or the *majority of its war eggs in the air basket.*" The italics are mine.

THE air service should, beyond all else, recognize the limitations of its weapons, and should not be carried away with claims which facts cannot substantiate, nor must it fool itself with the thought that it is the *dominant factor in warfare*. When looking back to the Great War we recognize that the airplane was only an infant, but that as the "eyes" of the army it proved to be of incalculable assistance. Again quoting General Fuller, "The army possessed no air sense, it had been educated and trained on methods which did not visualize air action, and though the war forced the airplane on the soldier, he did not understand it as a separate arm. . . . To assert its manhood it (the air force) clamored for independence; it wished to show what it could do, for it was proud of itself. It would bomb Berlin to hell, and end the war. Had the war continued, it might well have ended it, because after four and a half years of naval attrition and military attack, German *morale* had sunk so low that this bombing might have provided the last straw. Peace, instead of closing, increased the cleavage (between the army and navy on the one side and the infant air force on the other). The army clamored for its own air force, so did the navy, but *popular opinion*, stimulated by the memory of the German air raids, backed the Royal Air Force, and this service grew arrogant. It claimed *supreme control;* it would have won the war had it only lasted; it could win the next war; it could wipe out armies and fleets, and so it came about that Whitehall boiled with rage. The Royal Air Force had not won the last war single handed; nevertheless, undaunted it set out to prove how it could win the next. 'Suppose the French have 5,000 airplanes and we have 500, and we are attacked by France, what will France do?' The answer is obvious—she will bomb London. 'Granted' says the Air Force, and then turning to Whitehall it asks: 'And what will you do?' Whitehall sweats with anger, she can do nothing. . . . *Popular opinion* is startled; there lies France, but a cannon shot away, with a formidable air force and an army five times as big as our own. . . . Having scored this dramatic point, a considerable section of the Royal Air Force has now started to ride it to death. If the French can obliterate London, we can obliterate Paris, therefore the obliteration of capital cities is the object of war, since in these cities the will of the hostile nation can be attacked, and no navy or army can adequately protect it."

The proposal has often been made that the United States establish the air force as a separate department under a Secretary for Air, thus following in the footsteps of England where this has already brought trouble in its wake. The Air Ministry was established in England in 1917, and it has complete control over the air forces, whether land or sea, this new ministry being thus placed on a par with the Admiralty and War Office. The growth of air warfare is only of yesterday, but owing to existing conditions and to its rapidly increasing importance, it was felt that as a separate department the development of this organization would be insured under the most favorable conditions.

The birth of the British Air Ministry was, however, due to most unusual conditions. After the Battle of Jutland it was the general opinion that another major naval battle was highly improbable, hence the large naval air service would have but little naval work to perform, especially since the submarine menace seemed to have been halted, or at least no longer seemed so dangerous. News of the contemplated German drive for Paris however became known, and to those controlling the destinies of Great Britain it was felt this attempt might prove successful and result in the final defeat of the Allies. This required that every effort be made to meet this offensive, consequently it was decided that the air forces operating in France must be greatly strengthened. Most of the units of the Royal Air Force were in shape for assisting in this effort, and they were available, but were under the jurisdiction of the Admiralty, and besides this it was admitted that the administration of this force was inefficient; consequently it was decided that it was most vital to put all possible available forces on the western front under a single administrator, and the Royal

3. On Future Warfare.

Air Force was created for this purpose. This united force was thus created under conditions which could not possibly exist during a period of peace, and it is highly doubtful whether these same conditions would be repeated in any war in the near future.

It was not many months after the war, however, before the British Navy found great need of an air force which would be directly under the control of the Admiralty. The latter objected to the necessity of requesting the Air Ministry to assign air squadrons to the Fleet, since such dual control presented practical difficulties. The matter was placed before the British General Staff which, after conducting hearings, prepared a memorandum which presented the Staff's views on the whole air question. This memorandum advised as follows:

a) Any air units which constitute an integral part of the Fleet, as well as any Air formations capable of coöperating with the Fleet on the high seas, should be under the direct administration of the Admiralty.
b) Any air units which constitute an integral part of Army formations, and any air formations which are required to coöperate with the Army, should be under the direct control of the War Office.
c) As regards civil aviation, research, experiment and supply, this should be under the control of the Air Ministry, and being thus relieved of all responsibility for the employment of the air forces in both peace and war, this could be greatly reduced.
d) Each of the three departments of Naval, Military and Civil Aviation should prepare estimates for its own requirements, all of these estimates being then coördinated by the Committee of Imperial Defense before being presented to Parliament for action.

Upon receipt of this memorandum, and due to the continued dissatisfaction with the control of the air forces by the single agency, or Air Ministry, a subcommittee of the Committee of Imperial Defense was appointed with the mission of enquiring into the pregnant question of national and imperial defense, but the deliberations of this subcommittee failed to produce a plan looking to the coördination of the three services, Navy, Army and Air, by a Minister of Defense, the latter having appeared to be away out of the difficulty. The Admiralty truly states that in their view a Fleet Air Arm is absolutely necessary to a fleet of cruisers, destroyers, or submarines; also that aerial reconnaissance and aerial spotting are just as much strictly naval operations as are gunnery, torpedo work and wireless telegraphy. Consequently the Admiralty feels it is intolerable that, while they are held to strict accountability for the safety and success of the battle fleets, the air reconnaissance on which that safety and success in large measure depends should be performed by forces belonging to and under the jurisdiction of another service. This is undoubtedly true, but the organization of a separate air force was due to conditions which do not confront us in the United States, this because Great Britain is separated from her powerful neighbors or possible enemies by only a narrow strip of sea, with France, just across the Channel, maintaining very large air forces. Consequently the thought behind maintaining the British Air Force as at present constituted is based almost entirely on home defense.

IN our case it must be remembered that our country's defense is not concerned with narrow seas, such as the English Channel or the Mediterranean, and that invasion of our territory would most probably be by sea instead of by air. Both England and the United States, in the case of wide seas or oceans, are no doubt in accord that responsibility for defense and keeping communications open lies entirely with the navy. Hence in our situation I feel with the British Admiralty that the navy should control its own air force. As regards air invasion, it is impossible to visualize any great danger of air forces advancing step by step from Europe by way of Iceland, Greenland and Labrador, nor from Asia by way of the Aleutian Islands, since such invasions would require the pushing forward of large air bases. In the establishment of such bases the initial steps would be comparatively weak and could be prevented by suitable overseas expeditions, or, providing the bases should be established, they could be destroyed. Again, the force which such an enemy could possibly employ upon reaching the end of this string of bases would hardly justify the attending risks of disaster. Nor is it necessary in our case to establish a Department of National Defense for the purpose of coördinating the work of the Army and Navy, since our form of government as well as all precedents permits the President, in time of war, to assume practically dictatorial powers, hence additional political officers, with all the ramifications and expense they would entail, would be a useless burden.

This was another case where propaganda was used to assist in converting the British air services into a separate force, and the future alone will be able to unravel the mess which such separation will bring about during a future war, unless the latter is to be fought on the shores of Great Britain itself. Similar propaganda has been active in our country for some years, but it has as yet not been able to gain its goal. Shall *public opinion,* as was the case in England, assist in settling this question for us? I trust not, for public opinion is only the creature of the propagandist, and the former would not exist in such dangerous form if its instigator did not see that it would serve his own particular interests. The air service is and always will be a *component* of the Army and the Navy; it cannot fight wars alone, and it must be protected in its operations by the existing forces, consequently the object of a separate service is to make the Army and Navy subservient to the whims and fancies of a distinct class, but these will not win a war.

UNDER these conditions it is also interesting to examine what the other Powers have done in the matter. Turning first to Italy, we find that her situation is very similar to that of England. Italy has France on her northwest frontier, and through the base at Malta she has Great Britain within easy flying distance of her shores. There are two problems to be considered here, namely, the superior air forces of France on the one side, and the formidable British navy on the other, although the Italian air armada is not so far behind that of France. Italy has provided a powerful independent air force with the air defense of the country as its principal mission. She has also detached and assigned to the army an air fleet for furnishing auxiliary service, as well as for the local protection of vital areas. The navy also has been provided with a detached air force for furnishing auxiliary service and for the local protection of her coasts and shipping.

In France we find an army air service which, in the

matter of organization and promotion is identical with other branches of the army, but the necessary equipment is obtained through the agency of an under-secretary of state for aeronautics. As regards aviation in the navy, this is administered by the Naval Aeronautical Department, which latter is a part of the Ministry of Navy, the present organization of naval aviation having come into being during the Great War. In France we find a strong army, but a comparatively weak navy, while its possible enemies are Italy on the south, Germany on the east, and England on the west. Germany, however, is not at present in a position to be a serious military menace, but its highly developed civil aviation combined with its superior and constantly increasing manpower, plus its traditional hostility to France (which the latter has not attempted to conciliate), has undoubtedly influenced the military policy of France. In Germany's present weakness the principal mission of France's air force is no doubt that of neutralizing the efforts of the British Navy in the event of war with that country. The accomplishment of this mission, however, requires that she maintain superiority in the air, the principal reason also for England's present organization of her air force. Another serious mission of the French air force is the keeping open of communications with Africa across the Mediterranean. In consideration of France's manpower at home, this latter assumes vital importance, since in any major conflict it will be necessaary for her to draw on her colonies for assistance. If an independent air force as a third component of the defensive forces is the correct solution for the present-day military organization, it would appear that this colonial question of France would be the proper place for its application. But in spite of this, and with the strongest aeronautical force in the world, France incorporates it with her army, while to the navy is assigned what is deemed necessary as an auxiliary arm of that service.

Looking to Japan, we find that her geographical position corresponds more closely to that of the United States than to any of the other countries mentioned as regards close proximity to other strong military powers. The nearest neighbors are China and Russia; the former, as seen from the present Manchurian situation, hardly enters into the situation, but Russia may be considered the greatest menace Japan has to face today. China has developed no air force which might be able to arouse serious apprehension, but what Russia has accomplished in this particular is an unknown quantity at present. There is no doubt that Japan has given the possibility of an attack by the United States from the Philippines serious thought while developing her military policy. It is possible that Japan may initiate the matter some day by attacking the Philippines, and this latter eventuality has without doubt been given serious consideration by Japan. Both the army and the navy of Japan have been given aeronautical forces as auxiliary arms to these forces.

In Europe the civil populations are constantly bearing in mind a possible attack, hence every effort is being made for protection against aerial gas attacks in the "coming European war." As is seen from the foregoing, almost every nation is surrounded by potential enemies that could *possibly* obliterate entire unprepared populations within a few hours, consequently the prevailing idea of protection is occupying the thoughts of the average European. In spite of the fact that the League of Nations in 1925 launched its international convention to prohibit bacteriological and asphyxiating gas warfare, this agreement has created but little confidence in European minds, especially since only thirty-three nations have signed the convention to date, and fifteen of these must still ratify it. Besides this, virtually all of the signatories have made reservations, the principal one of which is that the convention shall be binding only on the signers; among these reservationists are England, France and Belgium. In Switzerland, which is entirely surrounded by larger nations, the matter has received deep attention. Here the army is of the opinion that a huge air force is the only hope against aerial gas attacks, while the Federal Council thinks that adequate distribution of gas masks combined with instruction and discipline will answer the threat. In France, it is reported, that in many villages and cities gas masks are on public sale, and the veteran military organizations are urging all citizens to equip themselves with them. From Poland we learn that the League will be asked to launch another convention which would insure world-wide aid to any country victimized by a gas attack. Finally, the International Red Cross has held meetings of experts in Brussels, Rome and Geneva where it was planned to create a bureau that will endeavor to keep the public informed on the latest gas discoveries and the latest means of protection.

Turning to Russia, we find the underfed peasants, as well as their brethern in the cities, being bombarded with statements to the effect that the capitalist nations have entered into a world-wide conspiracy with Russia's ultimate destruction as its goal. The Kremlin dictators tell their victims that the result of this conspiracy means either an armed invasion or a policy of starvation in order to overthrow Bolshevism, the principal danger being an attack from the air. The Russian is treated daily to pictures of what is coming to him unless he is prepared for the attack. For this purpose he is treated with ingeniously arranged tableux in the shop windows of Moscow and Leningrad depicting the bombing of Russian cities and towns by capitalist air forces, or the massacre of Russian peasants through poison gas dropped from capitalist airplanes; consequently the government plans to train some 17,000,000 persons in defense against gas and aircraft by 1933. Besides this, the Red Army authorities have simulated air and gas attacks on a grand scale in numerous areas, the neighboring civilians being carefully instructed in the measures they must take for their own protection.

RETURNING to our own case regarding a separate air force, we find General William Mitchell, formerly Director of Military Aviation in our Army, our principal proponent of this separate air force, or a department of the air, and he is reported as saying we should have an air force of 2,400 pursuit and bombardment airplanes, divided into an air division and two brigades. One brigade should be deployed along our Atlantic coast, one along the Pacific coast, and the air division in the center. Only ten per cent of this force need be continually under arms. The men composing the rest should work at their ordinary civil vocations except for six weeks maneuvers to be held every year. It should, he says, be a very economical force under these conditions, or cheaper than what we are keeping up now.

It will be noted here that ninety per cent of the men

will be *civilians* with six weeks of training every year, but these civilians must certainly be all of the first-class civilian aviators we have in the country who, at the outbreak of war, will drop all civilian air activity and enter the Army, because General Mitchell tells us that the airplanes must be of the highest quality and the men who handle them must be trained to the last minute. Unless these ninety per cent are all aviators by vocation, how would it be possible to *train them to the last minute* with six weeks of service each year? He also says that such an arrangement will be cheaper than what we now have; this may be true with only 240 airplanes in actual service but, as stated above, should we possess these 2,400 airplanes of the best type today, a decade from now they would probably be worth ten cents on the dollar, or perhaps less than that in view of the probable improvements this decade will bring us, and the cheapest is not always the best service. As seen below, however, we will have more than ten per cent of these 2,400 pursuit, attack and bombardment planes in service in 1932.

This problem is not only a moral one, but also one of economics, hence we should look at its cost with some degree of circumspection. The total planes on order and on hand on June 30, 1932, is estimated to be 1734, made up as follows:

| | | |
|---|---|---|
| Army | Pursuit | 404 |
| | Bombardment | 139 |
| | Attack | 105 |
| | Observation, standard | 368 |
| | Observation, amphibian | 36 |
| | Training, primary | 276 |
| | Training, basic | 194 |
| | Cargo | 60 |
| National Guard | Observation | 95 |
| | Training | 57 |
| | Total | 1734 planes |

and based on the 1931-32 prices for planes these 1734 air birds would represent an outlay of $60,107,472.

The total Army operating estimate for this air armada amounts to $76,526,030 for the year 1932, or it would cost on an average of $44,133 to keep each of these 1734 planes in the air. This estimate is exclusive of what is required for the Navy, the Coast Guard, Post Office, National Advisory Committee for Aeronautics, and the Departments of Agriculture and Commerce. The estimates for these latter services for the year 1930-31 amounted to $73,969,350, in which the Navy is responsible for $50,787,112. If this same figure holds good for the year 1931-32, the total operating cost for the Army and Navy air forces would be $127,313,142.

The cost of General Mitchell's 2,400 planes, based on the same percentage of individual character planes as those for 1932, or

| | | |
|---|---|---|
| Army | Pursuit | 558 |
| | Bombardment | 192 |
| | Attack | 144 |
| | Observation, standard | 510 |
| | Observation, amphibian | 48 |
| | Training | 652 |
| | Cargo | 84 |
| National Guard | Observation | 132 |
| | Training | 80 |
| | Total | 2400 planes, |

and also based on the same prices, would require the expenditure of $90,946,152, including those on hand or ordered, and this cost includes 732 training planes whose service in combat might be very problematical. However, General Mitchell requires 2,400 pursuit and bombardment planes instead of the 750 allowed in the above table, which if divided in the proportion given above would mean 1785 pursuit and 615 bombardment planes, which alone would mean an outlay of $116,114,520 for these two species, not considering what else might be necessary.

It is also interesting to note the cost per flying hour of these several types, including operating costs, gasoline, oil, plane parts, engine parts, clothing, parachutes, maintenance of buildings and grounds, machinery, tools, fixed equipment, supplies, expenses and depreciation on airplanes and engines, but not including the pay of officers and men. For this we have

| | | | |
|---|---|---|---|
| Pursuit | $ 96.76 to | $104.37, | depending on type of engine. |
| Bombardment | 175.70 to | 196.74, | " " " " " |
| Attack | 107.81 | | " " " " " |
| Observation | 76.73 to | 110.25, | " " " " " |
| Amphibian | 259.62 to | 268.47, | " " " " " |
| Training | 48.08 to | 74.89, | " " " " " |
| Cargo | 133.21 to | 229.41, | " " " " " |

These costs are all allowable during war, as is also what is necessary to maintain preparedness, but to stock up on airplanes of which only ten per cent will be in use, and matériel which will be of doubtful value a decade from now is quite a different question.

IF such an air armada should set out to win a war on its own, its activities would in great measure be necessarily directed against the "nerve centers," but of what does such a nerve center consist? It is no doubt a congregation of human beings who by their efforts have accumulated the products of the factory and the field within the confines of a city's area, or it is a place where the elements of human progress have found their highest expression. Will it not be possible for this aggregation of minds to find means for resisting such attacks? It is true we have the early failure of England before us, but time brought improvement, and we can certainly take a lesson from this. Disregarding for the moment such *immaterial* things as antiaircraft guns, is it impossible for the city to hide itself in clouds of artificial fog emitted from its many factory chimneys, and thus conceal its vulnerable portions? Can it not thus veil itself in a screen of fog which will blind the airman so that he cannot possibly locate definitely any worth-while bombing spot in the city? The answer is Yes! as witness the experiments conducted by the French Army on May 22, 1931, when the city of Tourcoing, of some 80,000 inhabitants, was covered with a thick fog-like gas, lying closely above the city's area, and which even defied the efforts of a moderate wind to disperse it, thus making the city invisible from the skies.

The defenders will certainly establish observation posts anywhere up to several hundred miles distant from the "nerve center," and although the airplane can move at the rate of 150 miles an hour, communication by telegraph between the outpost and the city will be almost instantaneous, and the necessary preparations will be made for meeting the raiders with a fog bank which can be completed before the raiders can appear.

(*The concluding part of "Sky Raiders" will be published in the March-April issue of* ARMY ORDNANCE.)

# The Recording Theodolite

## *A Device for Determining the Accuracy of Antiaircraft Fire*

By Roswell H. Ward*

THE rapid progress in the development of automatically controlled antiaircraft artillery batteries creates a corollary problem of the first order. Unless the effectiveness of this new weapon is determined to a fine degree of accuracy, correct rules for its tactical employment cannot be laid down. This effectiveness can be reduced to the expectancy of hitting aerial targets under various conditions of service. In addition to the problem of establishing the expectancy of hitting, there is another question to be answered. Are the units equipped with this type of weapon trained so as to actually produce results consistent with the established expectancy?

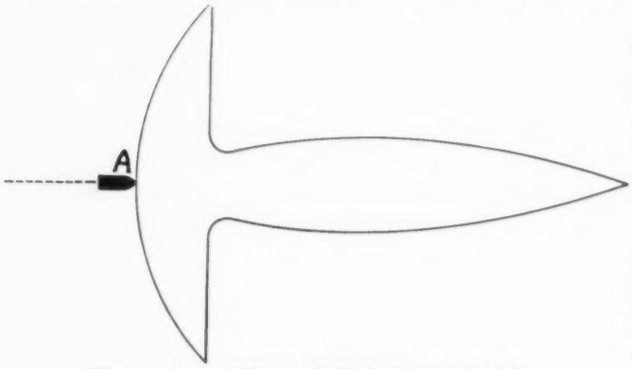



**Fig. 1. Area of Burst of High Explosive Shell.**

A cross-section of the pattern formed by the fragments of a bursting high explosive shell.

The Sperry Recording Theodolite has been developed in collaboration with Capt. Albert M. Jackson, Coast Artillery Corps, U. S. Army, to meet the need for an accurate and reliable instrument which can be used by the personnel of antiaircraft tactical units for determining the effectiveness of antiaircraft fire. It is a simple and reliable instrument which provides a complete and permanent record of the firing, under actual service conditions, without undue dependence on the human element.

The expectancy of hitting is developed from a series of firings against towed aerial targets and the effectiveness of fire is measured by the frequency with which the target is hit. By "hitting" is not meant the actual physical contact of projectile and target but rather the position of the point of burst with respect to the target at that instant.

THE pattern of fragmentation of a typical high explosive shell is shown in Fig. 1. The point of burst is at A. This pattern is the area of destruction of one shell burst. However, if we assume that we are firing on a target T (Fig. 2) from a gun position G, we can plot the area in which a shell will have to burst to reach the target. For instance, if the shell bursts at point $B_1$ and we superimpose the diagram of its pattern of fragmentation on Fig. 2, with the point of burst A (Fig. 1) over point $B_1$, it will be evident that the target T is included in the zone of fragmentation of shell $B_1$ and that it is a hit. A similar comparison of these diagrams, using bursts $B_2$ and $B_3$ as reference points, will clarify the apparent inversion of this "hypothetical target diagram" in contrast to the fragmentation diagram.

To determine whether the shell bursts are within the area of the hypothetical target, which in turn establishes the degree of effectiveness of the firing, it is evident that the linear deviation of the shell burst from the target must be measured in three dimensions, inasmuch as the shell burst can be displaced from the target in three planes: (1) It can deviate to the right or left; (2) it can fall short of the target or go beyond, and (3) it can burst over or under the line of position.

This statement can readily be understood by referring to Fig. 3. Here we see a material target being towed above the ground, represented by the plane FBT″. At the instant of its arrival at the point T it lies in the vertical planes FF′T′T″ and BB′T′T″. At this instant a projectile fired from B bursts at the point O which lies in the vertical planes FF′O′O″ and BB′O′O″. To determine whether or not this shot is a hit within the meaning we have just defined, the following elements must be determined: (a) The lateral deviation, i.e., the distance $OO_1$, measured in a plane perpendicular to the plane BB′T′T″; (b) the vertical deviation, i.e., the distance $O_1O_2$, this lies in the plane BB′T′T″, and

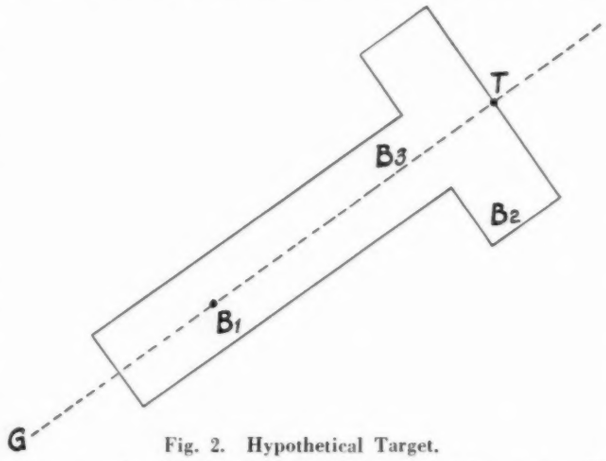



**Fig. 2. Hypothetical Target.**

A conventionalization of the actual pattern of fragments. If the material target is at the point T and the line GT represents the direction of the firing battery, then any shots bursting within the boundary of the figure are "hits," that is, the material target would be included in the pattern of any shells bursting within this volume.

(c) the longitudinal deviation, i.e., the distance $O_2T$, also measured in the plane BB′T′T″. It will be noticed that these three dimensions are measured in three mutually perpendicular directions, namely, length, height and breadth.

*Assistant to Vice-President, Sperry Gyroscope Company, Inc. Copyright, 1931.

To obtain these three dimensions for any shot it is necessary to measure eight elements of this problem. Referring again to Fig. 3, the distance BF (the base line) is known and is constant. The other necessary elements are the angles indicated by the double-headed arrows ($b^1$, $b^2$, b, the angle $OBO_1$, $a^1$, a, $a^2$).

ANY method of analyzing antiaircraft fire would be useless unless it permitted a record to be made under conditions which are similar to those encountered in actual military service. Therefore, to accurately determine the expectancy of hitting we must simulate as closely as possible the conditions that would actually be encountered when firing antiaircraft artillery against an aerial target, giving due care to the safety of the personnel engaged.

This requirement makes it necessary to take into consideration the following characteristics of antiaircraft gunnery: (1) The high velocity of the target and its ability to maneuver rapidly in three dimensions. (2) The small size of the towed target usually used in antiaircraft practice and its consequent low visibility. This is due to the fact that the characteristics of the towing plane limit the size of the towed target. Hence at ranges at which it is sometimes desired to fire, the target is practically invisible to the unaided eye. (3) The high rate of fire. The maximum volume of fire is desirable and the modern antiaircraft artillery battery of four guns is capable of delivering fire at the rate of 120 rounds per minute.

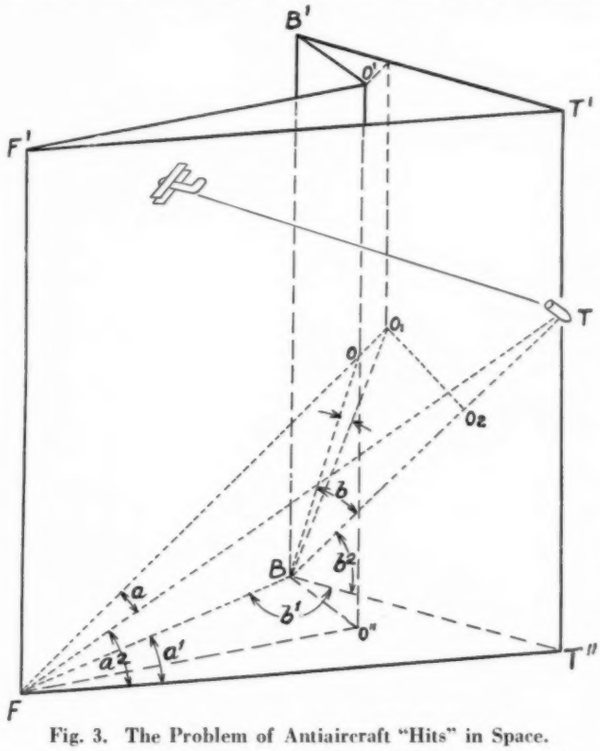



**Fig. 3. The Problem of Antiaircraft "Hits" in Space.**

A battery is located at "B" and theodolites are located at "B" and "F" in the same horizontal plane FBT″. The target lies in the two intersecting vertical planes, BB'T'T″ and FF'T'T″. As it is seen along BT its position is T. A burst occurs in the two intersecting vertical planes BB'O'O″ and FF'O'O″ and along BO. Hence O represents the position of the burst. The two theodolites measure and record the angles indicated by the double-headed arrows. Then knowing the distance BF the values of $OO_1$, $O_1O_2$ and $O_2T$ can be computed.

In the above diagram the shot burst to the right of the target a distance $OO_1$, above the line of position a distance $O_1O_2$ and short of the target a distance $O_2T$.

The requirements which have been outlined can be summarized as follows: (1) The displacement of the shell burst from the target must be measured in three dimensions. (2) The measurement must be made under conditions com-

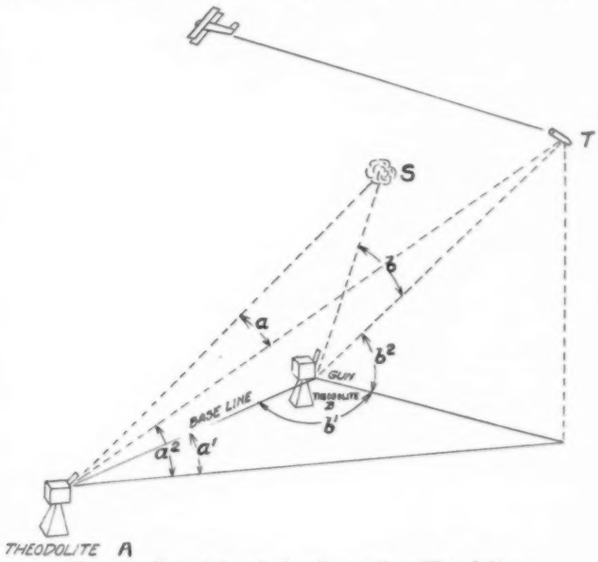



**Fig. 4. Principle of the Recording Theodolite.**

Theodolite A records a in plane ATS, $a^1$ in horizontal plane, $a^2$ in vertical plane. Theodolite B records b in plane BTS, $b^1$ in horizontal plane, $b^2$ in vertical plane.

parable to actual service conditions, including—(a) Highly maneuverable target, moving at high speed; (b) low target visibility, and (c) high rate of fire.

To these requirements, the following conditions can also be added: (3) The method of measurement should be simple, compact, and suitable for use under antiaircraft training conditions; (4) it should function without undue dependence on the human element; (5) a permanent record of the basic data on which the firing results are based should be available; (6) it should be possible to interpret the firing data with a minimum amount of computation.

TO ascertain the effectiveness of antiaircraft fire, in accordance with the requirements which have been outlined, the equipment used must fulfill two functions: (1) It must record the relation between the shell bursts and the target while firing is being conducted at a high rate of fire, and (2) it must measure the seven angles illustrated in Fig. 3 in order to fix the relation between the shell bursts and the target.

To make a record of the shots, an adaptation of the standard professional moving picture camera is used, since the photographic film is the ideal medium for recording the position of the shell bursts and the target at a high rate of fire.

To measure the angles required the moving picture camera is combined with a theodolite. Basically a theodolite is an optical instrument for measuring angles, such as the angular deviation of a distant object from some established reference point. The familiar surveyor's transit is one form of theodolite. In the recording theodolite the visual impression of the observer is replaced by the photographic record

of the moving picture film; and the angular deviation is expressed in mils instead of in degrees. One of these theodolites, or "photographic angle-measuring devices" can only measure angular deviation in two planes. To measure the angles required in *three* dimensions, two recording theodolites are used, located at either end of a common base line. The complete system is illustrated in Fig. 4

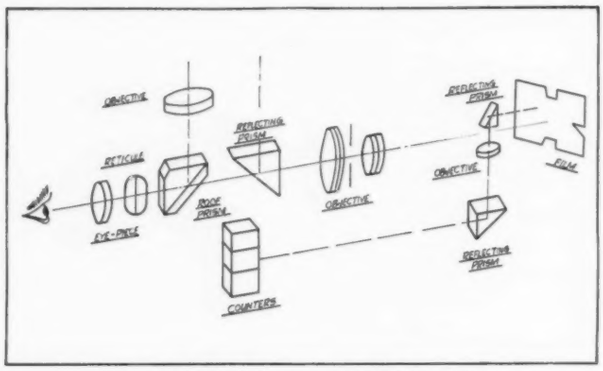



**Fig. 5. Optical System of the Theodolite.**

together with an explanation of the angles which each instrument measures.

The optical system of the recording theodolite is shown in Fig. 5. The observer views the field of vision directly through the eyepiece and lens and prism system connected with it, the center of the field being defined by cross-wires. The same field of vision is also reflected into the moving picture camera by another system of lenses and prisms. A high degree of magnification is necessary to obtain images of suitable size, and a wide field of vision is provided to make certain that all but the most erratic shots are recorded. The complete instrument is shown in Fig. 6.

The visual eyepiece is, in effect, a "finder" for the moving picture camera. The observer keeps the cross hairs trained on the target—or adjusts the theodolite on a selected point in space—and the position of the target and the burst is photographically fixed.

Having made provision for obtaining a photographic record of the shell burst and the target, it is necessary, when interpreting the result of the observations, to know the angles of azimuth and of elevation of the theodolite at any given time. This is accomplished by having a set of especially designed counters fitted to indicate the angle of azimuth and the angle of elevation. The images of these counters are reflected on to the margin of the film by a prism.

It is also necessary to have a time record device, primarily to permit "matching" views of a given shell burst taken from the two separate observation stations. A counter, similar to those indicated above, is arranged to advance one digit for each electrical impulse received from an electrical time interval device, and is also photographed on the margin of the film.

Under conditions of poor visibility or when the theodolite is trained on a selected point in space, no image of the target will appear on the film. The center of the field of vision, which is always the position of the target, is defined on the film by reference points which are photographed on the edge of each individual "frame."

A complete photographic record, in *two dimensions,* of the position of the target, the shell burst, the azimuth, the angle of elevation and the time is thus obtained by the theodolite. The appearance of the film is shown in Fig. 7.

The theodolite is constructed with the degree of precision usual for fine optical instruments and the various optical components are the best obtainable. The moving picture camera (utilizing standard 35-mm. film), is simple and rugged and is equipped with film magazines with a capacity of two hundred feet. One full magazine is sufficient to record about five minutes of firing.

The speed of exposure of the cameras can be varied from five to twenty exposures per second by adjusting the rheostat provided for this purpose. A tachometer is fitted to the camera to indicate the speed.

The time interval device which is connected to both instruments and synchronizes the record, operates on the metronome principle with mercury contacts and can be adjusted to register any desired time interval. It is illustrated in Fig. 8. Storage batteries are of the nickel-iron alkaline type and are used to provide power for the cameras, to illuminate various parts, and to synchronize two or more theodolites (through the time interval device). They are provided with a multiple cable and plug for making all connections to the theodolite.

The complete recording theodolite equipment consists of the following elements: 2 recording theodolites, 2 battery boxes, 1 time interval device, 1 film developing outfit and 1 projection outfit.

THE theodolites are usually set up at the ends of a surveyed base line, usually from 5000 to 6000 yards long. One instrument is established directly behind the firing

**Fig. 6. The Recording Theodolite.**

battery and the other on whatever flank is most convenient and where visibility conditions are best. Since an electrical connection must be made between the two instruments, a field telephone line is usually laid for this purpose and is connected to the time interval device, which is preferably located indoors and some distance from the firing point.

Each theodolite is operated by two men. An observer

who trains the instrument on the target and an assistant who starts and stops the recording mechanism. (Provision is made for a signal to the distant observation station to guide the observer and assistant.) For recording the position of bursts in relation to a selected point in space, the instruments are trained on this point and the recording carried out as described.

It is also possible to determine the trajectory of tracer bullets fired from machine guns or automatic cannon by day or night; to measure the angular velocities of an aerial target and to determine the time-altitude relation of an aerial target.

A complete developing outfit is provided for finishing the films after the record has been made. The negative thus obtained is used in the projector, it being unnecessary with this type of record to make a positive print. The projector is hand operated and each individual "frame" can be kept on the screen as long as required to make the readings.

After the negative film is dry, it is wound on a reel and placed in the projector. An image of each exposure, greatly magnified, is projected on to the special projection screen and by means of the graduations thereon, the angular deviations of each shot are determined.

It will be recalled that for each shot, we are interested in seven angles, as follows: (a) The azimuth of the target from the battery station; (b) the angular height of the target from the battery station; (c) the angular lateral deviation of the burst from the target as seen from the battery station; (d) the angular vertical deviation of the burst from the target as seen from the battery station; (e) the azimuth of the target from the flank station; (f) the angular height of the target from the flank station; (g) the angular lateral deviation of the burst from the target as seen from the flank station. In addition, we are interested in the time of occurrence of each burst, both from the necessity of pairing the two views and from an interest in the rate of fire of the battery.

In (a) the target has an elevation of 523 mils, azimuth 2342 mils. In (b) 0.1 second later the target has an elevation of 527 mils, azimuth 2348 mils, the time counter has advanced to 0013 and will remain there for one second. A burst has just occurred. In (c) the smoke has formed and the target has moved away from the point of burst.

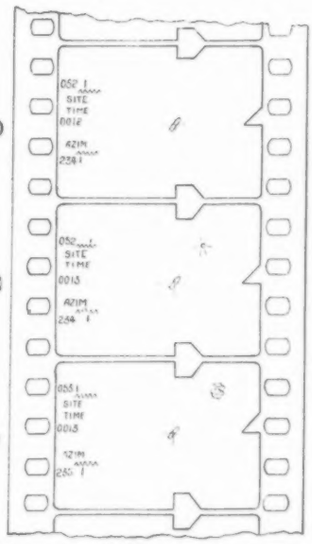



**Fig. 7. Typical Segment of Film.**

Hence for recording these data it is convenient to use a tabular form prepared for the purpose.

In addition to knowing what percentages of the shots fired were hits, it is often advisable to know the average conditions under which this proportion of hits was obtained. Hence a complete analysis of a firing might properly include determinations of average altitude of target, average angular height, average horizontal range, rate of fire, ground speed of target, etc.

Two methods present themselves for the computation of the required data, first a graphic method and second a purely mathematical method. The graphic method necessitates the use of various instruments such as plotting boards, charts, etc., together with certain arithmetical calculations, whereas the mathematical method requires no special equipment.

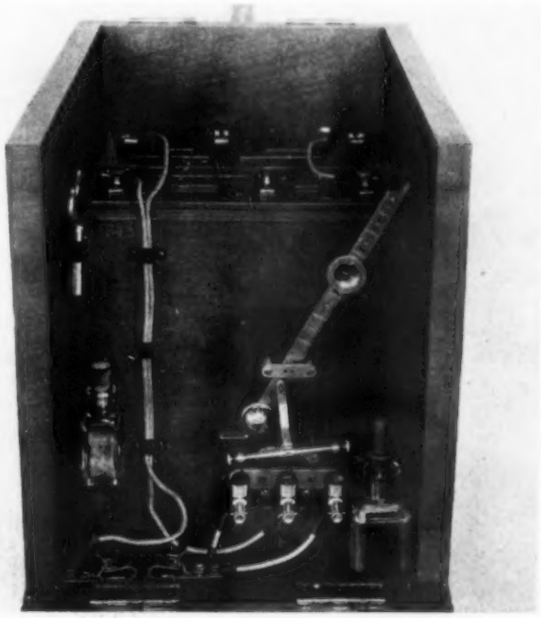


**Fig. 8. The Time Interval Device.**

For the mathematical solution special computation work sheet is furnished. It will be remembered that eight arguments are necessary to the solution of each shot. These arguments are entered in the respective columns on the work sheet and by following the progressive steps the whole firing is analyzed. The amount of computing depends upon the degree of thoroughness to which the analysis is to be carried. As the computing proceeds, it becomes apparent that while certain shots might possibly be hits, others cannot possibly be. Hence if only the percentage of hits is required, the computation of only the doubtful shots need progress. If, however, it is desired to have a pattern of all the shots, obviously each shot must be worked out to the end.

The instrument can be set in azimuth and elevation to within .1 mil. It will record its own setting to within .5 mil. The accuracy of measurement of deviations depends on the degree of enlargement to which the image is subjected. Projecting on a scale of ten mils equal one inch, angular deviations can be measured up to .5 mil.

When, due to poor visibility, the image of the target does not appear on the film, deviations must be measured from the center of the exposure as determined by the indicating reference points. The accuracy of this reading depends on the accuracy of the observer in keeping the instrument trained on the target. (The probable error of observers has been estimated generally as in the magnitude of .5 mil.)

ARMY ORDNANCE

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## *Month by Month*

**Cleveland Ordnance Advisory Board**

RECENT announcement of the acceptance by Col. Frank A. Scott of the chairmanship of the Cleveland Ordnance District Advisory Board completes the roster of that important body. All members of the board are well known in ordnance and industrial circles for their public-spirited interest in munitions and for their marked ability in public and private undertakings.

That men of vision and proved capacity are available and willing to help steer the ordnance ship on its course of industrial mobilization is no less a tribute to the individuals themselves than it is to the cause they sponsor. All the members of the Cleveland Advisory Board have achieved distinction in the realm of national defense. Their example, as shown by their continued service, is one of those beacon lights to which an amazed populace may turn when other so-called leaders forsake time-honored traditions for the sweet nothings of those who preach that war can be no more. Much has been written in this place and in countless other and more influential places and much has been said in public meetings about the wisdom of our national defense plans and policies. No word, printed or spoken, can approach in value the example and leadership of those—in Cleveland and elsewhere—whose devotion to ideals is evident by their service. American defense is indeed fortunate that throughout the country there are men of the Cleveland Ordnance Advisory Board type who stand staunchly for munitions preparedness. Their influence is in sharp contrast to those who will not remember the vicissitudes of a few years ago. The war outlawers plot curves for every other trend and are guided by them. The war curve which runs more definitely through the history of man than any other they will not plot. Reassuring it is then that there are saner minds who follow not only the graphs of major emergencies but also the munitions graphs so necessary to return the war curve to a straight line whenever it tends to sag.

The Advisory Boards of the Ordnance Districts throughout the land can be looked upon as the directors of local munitions planning and effort. Indeed their contribution to national security is of the highest degree for upon their counsel depends the efficacy of industrial mobilization.

**Interchangeability, a Dogma of Ordnance Doctrine**

OF the many contributions armament production has made to peace-time industry that of interchangeability of parts is probably the most fundamental. For this to Whitney and North and the other New England gunsmiths goes the credit due the pioneers. The results of their skill are apparent today on every side. The entire world of reality, and some of that of make-believe, now has its many "gadgets" predicated on the principle of interchangeability. Ordnance, first sponsor of that principle, is as much concerned with its application today as it was in the beginning. For that reason machine tools and gages are of prime importance to the national defense. While it is not probable that the corner drug store will ever carry replacement parts for howitzers as some do for more popularly known conveyances, the parts will be interchangeable nevertheless even though a heavy repair shop be required to do the adjusting.

These reflections arise from recent unintended instructions requiring bolts of the Springfield rifle to be marked with an identifying number corresponding to the serial number of the rifle itself. The instructions were promptly changed, however, and thank heaven for it! No innovation could be quite as damaging to the whole ordnance plan of production and repair as this apparently trivial procedure. American ordnance from hand grenade to seacoast gun is individual in design and universal in interchangeability of respective parts. If it is not meticulously kept so battles may be lost while Private Jones enlists Private Smith to help find a bouchon assembly of the same serial as the release mechanism of his grenade. That or anything like it would be bad all around—bad for the battle, worse for the Army, and worst for ordnance.

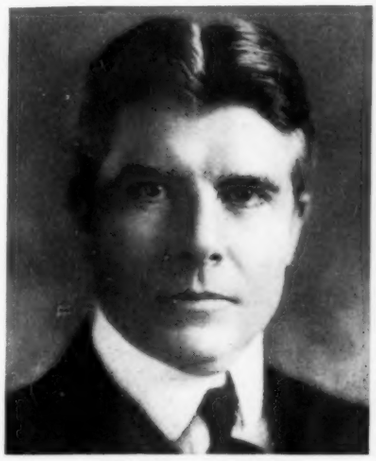
Standardization, simplification, mechanization—all come down to terms of machine tools, gages, quantity production, interchangeability. Should someone some day compile the fourteen points or the thirty-nine articles or even the ten commandments of ordnance design and production, No. 1 must perforce be—interchangeability of parts.

**Bulletins on Everything But Bullets**

DEBATE in the United States Senate on January 6, 1932, revealed the astounding fact that some $20,000,000 was expended by the various bureaus of the Federal Government last year for the preparation and publication of bulletins of all sizes and shapes and on nearly every conceivable subject. Some of the titles in the list are: "Utilization of Calcium in Spinach," "Lamb as You Like It," "The Use of the Metric System in Nutrition," "Where Sheets Wear Out," "Vitamins in Relation to Salad Dressing," and "Ensembles for Sunny Days"! Many were prepared by experts who in some cases were sent throughout the country and sometimes abroad to collect the data.

Of questionable value though this situation is on its face and while joining whole-heartedly in voicing the need for the discontinuation of useless expenditures, one may be permitted to comment on the trend of the bulletin business in recent years. A case, close to our hearts, concerns the annual reports by heads of technical services of the War Department especially those of the Chief of Ordnance. From

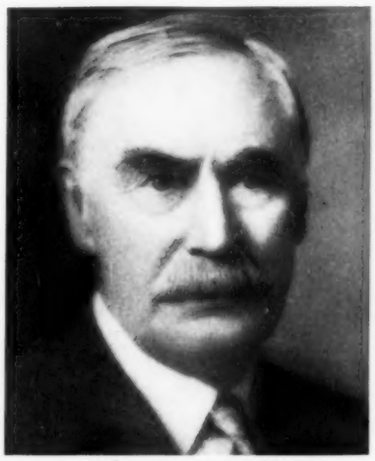
# *Cleveland Ordnance District Advisory Board*



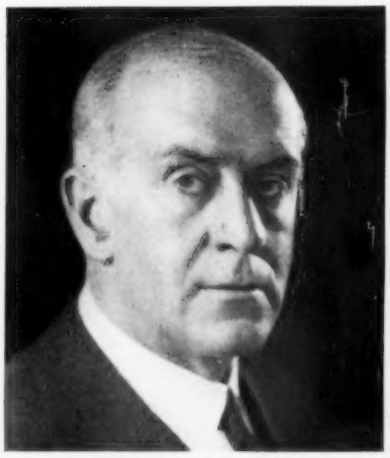
FRANK A. SCOTT

HENRY C. OSBORN
District Chief

BENEDICT CROWELL



JAMES A. CAMPBELL



WINTHROP WITHINGTON
Assistant District Chief

ALEXANDER C. BROWN

HENRY G. DALTON

MAJ. WILLIAM A. BORDEN
Executive Officer

ALLYN F. HARVEY

1864 to 1920 this valuable record, which the annual ordnance story is, was appropriately printed and bound. Today the series is a reference work of real worth. With the post-war miasma a joint committee on something or other decreed that public funds could not be used for so unworthy a purpose so the Ordnance reports since 1920 have of necessity become short-lived, typewritten, duplicated brochures of flimsy form. They contain highly technical details of value to civilian engineers and industry and are an essential part of the national record. They will be of increased value when dissertations on sun suits and spinach are forgotten. But the funds used for their printing and adequate preservation are no longer available.

It is a far cry from "Self-Help Suits for the Small Boy" to, let us say, "American Ordnance in 1931." A bulletin on the former vital subject exists in style and profusion; the status of the latter is not worthy of the Government printing press. If our guess is not colored with chagrin we surmise that printed data on self-help suits (whatever they are) will not be much consulted in the day when we may be groping in the dark for self-help on defense subjects—now so lightly considered. But according to current philosophy national defense is decreasing as the business of government while "Sun Suits," etc., etc., etc., typify why our fathers banded together "to form a more perfect Union, establish Justice, insure domestic Tranquility, provide for the common defense, promote the general welfare and secure the Blessings of Liberty." The slogan of some of our compatriots might well be "Millions for bulletins on the eradication of field mice but scarcely a penny for bulletins on the fabrication of field guns!" Oh-hum!

THE proposed Administration of Public Works which would coördinate all construction activities of the Federal Government in one executive department has many arguments in its favor. The most generally experienced one, perhaps, is the labyrinth an inquirer must follow to locate the organization responsible for any particular project. For public roads the engineer, contractor or information seeker is referred to the Department of Agriculture, for public buildings to the Treasury, for national parks to the Department of the Interior, and so on and on. The economical and organizational advantages to be gained from a consolidation of such diverse authority under one responsibility are apparent. On one score, however, molestation of the present order will be a distinct disadvantage. We refer to the proposal that rivers and harbors work now, and for many years past, so splendidly executed by the Corps of Engineers of the Army, be transferred to the projected Public Works Administration.

**Army Engineers and Public Works**

There are weighty reasons why this traditional function should not be withdrawn from the Army Engineers. Among these may be listed the efficiency with which the many projects are executed and the extremely low operating costs of the military personnel compared with like costs of civilian direction. On this point one might cite the pay of a regular Army officer in charge of an Engineer district as against that of a civilian with the same responsibility. Reference can also be made to the phenomenal record of the Corps in handling its varied projects envolving many millions annually wherein only one case of malfeasance has occurred and that was promptly corrected by the Corps itself.

Our concern, however, arises from even more fundamental aspects of the case. Fortification, the prime function of the military engineer, is still a basic necessity of the national defense. Although seacoast defenses are not the live issue they were in the days of Endicott and even if newer methods of warfare have relegated many of our more sedate forts to the zone of secondary value, still fortification, gun emplacement, river navigability and harbor control are, and will ever be, definite parts of the national defense. To say that the Corps of Engineers could not function as efficiently by individual detail of its officers to carry on the work under the supervision of a Director of Public Works is not to quibble about technicalities nor to jealously guard the powers of a branch of the national defense to which armament has important relationship. The fact is that our coasts and navigable rivers are potential defense areas of the first order in time of war. No military tenet is more definitely established in the entire history of nations. For this basic reason the control and development of these natural factors should continue to be viewed from, and administered by, the military engineer whose eye for safety and security sees also the advantages of peacetime progress.

FROM New York now come forward International Scientists with the latest fool-proof device for preventing war. One of their number offers "glass snow" described as small particles of glass with jagged edges impregnated with poison! Aside from its novelty of form it goes other wholesale death-dealing devices one better. Not only will it rid certain areas of entire populations but it will keep the locality uninhabitable for months. This will be accomplished by the wind blowing the particles like snow to inflict its venom upon unfortunate individuals who happen near. The scientists claim that a huge supply of this glass snow will serve as sufficient threat to keep off intruders and thus banish war forever. The world will be bombarded to peace with (glass) snowballs!

**Battle the Enemy with Snowballs!**

International Scientists and other peace organizations give the defense advocate a run for his money in trying to keep up with their varied schemes. These cover the entire gamut from no protective devices whatever to those of horrifying effect. Some would insure national protection by passive resistance; others would accomplish the same end by active reprisal. Whether it be by high sounding phrase for peace at any price or by death-ray and now poison "snowballs," the propaganda runs along in undiminishing array to the delight of some of us and to the disgust of others. Were the camel's back not already broken this prospect of police power residing in glass snow would be the last straw—until the next rhapsodist appears to enforce peace with anything but powder and shell.

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Due to limitations of space Part II of the article, "Tactics and Matériel" by General M. J. Challeat, announced for publication in this issue, is unavoidably withheld. It will appear in the March-April number of this Journal.—Ed.

# *A Department of National Defense—Economy versus Efficiency*

**An Editorial**

MANY old chestnuts are being raked out of the fire in the present stampede for economy in Federal expenditures. That hardy perennial, a Department of National Defense, is again presented for the edification of the over-burdened taxpayer and one more attack is leveled at our armed forces in the guise of a cure-all for alleged wastes. Not satisfied with preaching the devastating doctrine of the burden of our armament in the face of major disturbance in the Far East well-meaning individuals go one better and urge the merging of the Army and Navy into one organization "for greater efficiency and economy." The latest move in this direction is by Representative Byrns of Tennessee, chairman of the powerful Appropriations Committee of the House of Representatives. On behalf of his bill in the present Congress to create a Department of National Defense he cites greater efficiency and considerable saving, the unified purchase of equipment, the elimination of competition in developmental work, the more economical use of transportation of material and personnel. On the score of munitions improvement, proponents of the measure claim "Each department is the purchaser and to some extent the manufacturer of munitions of various kinds. For this purpose each also maintains considerable establishments for the repair of such equipment. Each separate organization now maintains depots, warehouses, posts, stations, magazines and other facilities for supply, repair and maintenance purposes." Unification of the two departments and the creation of a separate air arm, it is claimed, would eliminate duplication with consequent advantages of increased efficiency and lower cost.

DISCUSSION of such a merger is not new. It has been intermittently fostered and repeatedly opposed not only by professional soldiers and sailors but by civilians familiar with the needs and missions of our national defense services. The reasons which held good in the past are still incontrovertible. The aspects of the question insofar as the tools of defense are concerned are worthy of restatement and emphasis even when they apparently run counter to the interest of the taxpayer. We doubt that with a merger of the two services the taxpayer, however, would save a great deal and are certain that he would lose in the long run. National defense is not one of those things to be measured by the present out-of-pocket expense. True, the American taxpayer has looked at it that way from the beginning and as a consequence with each recurring emergency he has paid the piper a million fold. In the present state of things he would do well first not to tamper with the present set-up and second not be penny wise and pound foolish.

Our principal concern, of course, is the effect of a unified department of national defense on the adequacy of American munitions. To the uninitiated there is something to be gained by joint utilization of facilities by the Army and Navy. This copartnership already exists in many respects. Small arms and small arms ammunition is the leading category where joint facilities are used. But the Army does not attempt to build submarines for the Navy and the Navy does not attempt to lay down specifications for tanks. There are divergent fields in which the two services operate which can never be unified other than in name.

But our viewpoint is not based on the exigencies of the present just as the services should not be bandied about solely because of the needs of the present. Our manufacturing arsenals, our repair and supply depots, operating even on reduced rations, have their greatest value in their future service. That they are training centers for a non-commercial art from which a cadre of expert technicians will emerge in the event of war to steer industry in the devious ways of munitions production is reason aplenty for holding each to its mission. And no immediate element of cost, constantly reduced as it has been, is worth the jeopardy involved.

IT is especially enlightening to restate the objections of Hon. John W. Weeks to a similar consolidation proposal in 1924. The then Secretary of War said:

"Consolidation is not the panacea its advocates would have us believe. On the whole, development by evolution, which is constantly increasing the efficiency of the present organization, is much the sounder foundation upon which to build. * * *

"To summarize, it may be stated:

"That national defense is not a clearly defined function that can be intrusted to a single service or to a single department. It is a function of the Executive, and all the departments are involved in the discharge of this function.

"That the Army and the Navy have distinct missions which demand separate and specific equipment and training.

"That the duplication of effort and the expenditures resulting therefrom are more apparent than real. . . . Where such duplication and expenditure exist corrective measures can be applied through means now available.

"That unity of policies and plans and effective coöperation in joint operations of the Army and Navy is essential.

"That in the Joint Army and Navy Board, the Joint Army and Navy Planning Committee, the Joint Aeronautical Board, the Army and Navy Munitions Board, the local joint planning committees, and the Bureau of the Budget, as now established, effective means exist to accomplish the results indicated above, and that experience and what has already been accomplished demonstrate that with the support of the Secretary of War and the Secretary of the Navy the means are adequate to the ends in view.

"That the proposal to consolidate the War and Navy Departments into a single Department of National Defense should not be favorably considered at the present time in that such action will not accomplish the objects claimed for it by its sponsors, will adversely affect the efficiency of the Army and Navy and will serve to impose an additional agency between these two agencies of the Commander in Chief, the President."

These are still the professional viewpoint as reiterated, by Secretary Hurley for the War Department and by Secretary Adams for the Navy, only a few days ago.

# Association Affairs

### Second Annual Meeting of the Birmingham Post

THE second annual meeting of the Birmingham Post, Army Ordnance Association, was held December 1, 1931, at the Mountain Brook Country Club, Birmingham, Alabama. Colonel Theodore Swann, President of the Post, presided. One hundred and fifteen members and guests were present. The honor guests were: Hon. F. Trubee Davison, Assistant Secretary of War; Maj. Gen. Samuel Hof, Chief of Ordnance; Maj. Gen. James E. Fechét, Chief of Air Corps; Maj. Gen. Frank R. McCoy, Commanding General, Fourth Corps Area; Col. George Vidmer, Inspector Instructor, Organized Reserves, State of Alabama; Col. Joseph I. McMullen, J. A. G., Washington, D. C.; Maj. John C. Curry, Commanding Officer, Maxwell Field, Montgomery, Ala.; Maj. Burton O. Lewis, Ordnance Officer, Fourth Corps Area; Lieut. William S. Biddle, Aide de Camp, Fourth Corps Area.

COLONEL SWANN, in opening the meeting, said: "In behalf of the Birmingham Post, Army Ordnance Association, I wish to welcome our distinguished visitors. We have been looking forward to your visit on the occasion of the second annual meeting of the Birmingham Post. We consider it a distinct pleasure and privilege to have you with us tonight.

"Your messages will be given direct to leaders of industry. Birmingham's prominent manufacturers, executives and engineers and our outstanding commissioned officers are present here. I can assure you that your messages will give us added incentive in fostering our effort to assist in the National Defense.

"The Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness as the Nation's strongest guarantee of peace. It is a unique organization—it supplements as best it can the industrial war planning activities of the Government and endeavors to assist them by every possible means in the perfection of those all important plans. Ours is not a trade organization for the simple reason that there is no such thing as a munitions industry in America. It is not a service organization because less than nine per cent of its members are officers in the Regular Army. It is composed for the most part of executives and engineers in industry who see in industrial preparedness one of the vital national defense problems of the nation. In my judgment there is no more patriotic or more important field of coöperation in which such men as you take part.

"The Association has over 3,000 in its membership, while our Local Post has a membership of 102. We would like to increase our Local Post membership and we hope that those who are not members will join with us when given an opportunity at a later date. It is worthy of your serious consideration.

"The War Department has recognized that the mobilization of industry for war has become fully as important as the mobilization of man power, and this is recognized in that part of our National Defense Act of 1920 which makes The Assistant Secretary of War responsible for the 'assurance of adequate provision for the mobilization of material and industrial organizations essential to war-time needs.'

"The Birmingham District Ordnance Office is engaged in this work. That office is planning for the effective use of the industrial resources of the southern states. As you know I am the Acting and Assistant Chief and Captain Hauseman the Executive Assistant, Colonel Sewell, who is temporarily absent in Chicago, being the District Chief.

"It is not my purpose this evening to elaborate on the important work of industrial war planning in the District—except to say that if war should unhappily come along we would know what we want, how much we want, where we were going to get it, how we were going to get it and when we were going to get it.

"I cannot let this opportunity pass without paying tribute to the excellent work for munitions preparedness that has been done and is still being done by Mr. Ryding, President of the Tennessee Coal, Iron and Railroad Company, with the assistance of one of our reserve officers employed by Mr. Ryding—Major Parker. The Chief of Ordnance, on October 16th, wrote: 'The factory plan of the Tennessee Coal, Iron and Railroad Company for the production machining of 155-mm. shell Mk. VII has been carefully reviewed. With the possible exception of this company's plan for the production of forgings, this is by far the best prepared factory plan which has been forwarded to Frankford Arsenal for review. The plan is complete in all essential details and manifestly represents considerable expense to the company and the devotion of much time on the part of the individuals who prepared it.'

"I also wish to pay tribute to others who have given us complete plans: the Hardie-Tynes plan for machining 75-mm. shells as prepared by Mr. Tynes and Lieutenant Colonel Hamilton; the Continental Gin Company's plan as prepared by Mr. Woodruff and Colonel Merkel; the Goslin-Birmingham plan as prepared by Colonel Morrow and Major Ephgrave; the Stockham Pipe and Fittings Company plan for manufacture of fuzes, and the ferro-manganese plan as developed by Mr. Klugh of my organization. In addition, we have received and are working on plans from many other companies in our district located throughout the South, all of which involve the expenditure of considerable funds and time. In my opinion these plans are not surpassed by any plans of our northern and eastern companies. I know when others are solicited for a production study of the munitions you have tentatively agreed to manufacture in an emergency—they will be worth while and that they will be given cheerfully with a view toward aiding National Defense. In all of this, in time of need, we would be assisted by our very able Advisory Board.

"We are also building up a Reserve officer organization and are training these officers in the duties they would be required to perform if called to active duty. Our newest recruit, and as you recognize, a valuable one, is Lieut. Col. Frank Crockard."

ASSISTANT SECRETARY DAVISON outlined the aircraft developments in this country, emphasizing the tremendous progress in the past two years. Mr. Davison said: "While this government has not captured the speed record, its fighting craft are second to none.

"The service now has pursuit planes that will make 200 miles an hour, and soon will have planes that will make 250 miles an

hour with their full military load. Bombardment planes have developed 188 miles an hour with full military loads. The United States, counting both Army and Navy planes, ranks fourth in the number of fighting aircraft. In time of war the Navy planes will be with the Navy and so, counting only Army planes, this government stands fifth."

Mr. Davison also outlined to the meeting the tremendous value of such an Association as ours, stating that without the work of organizations like the Army Ordnance Association the country would soon be back into the depths of its proverbial unpreparedness.

MAJ. GEN. SAMUEL HOF, Chief of Ordnance, cited the advantages of industrial planning as a national defense measure and presented a gratifying account of the coöperative measures now in effect between the representatives of industry and the War Department for munitions production in time of war.

Contrasting our present policies with the waste and inefficiency of unorganized effort in the World War, General Hof said: "The estimated demand of the Army and Navy on the steel industry is now but thirteen per cent of the capacity—not an alarming quantity when non-essential uses are curtailed. Of course, our demand must be coördinated, facilities allocated, priorities established, but this is all covered by the plans of The Assistant Secretary of War."

He explained that the present Ordnance plans for a major emergency call for an expenditure of $4,500,000,000 instead of $15,847,000,000 as attempted during the World War.

Continuing General Hof said, "Certainly our present procurement plans are relatively small as compared with what was attempted during the World War. This reduction results from a more definite determination of requirements, in part from our stocks of munitions remaining from the last war, and in great part from our planning for procurement. See the difference between planned versus unplanned procurement."

In closing, General Hof spoke of educational orders as being the most essential requirement not yet provided for in procurement planning. He said, "No manufacturer quite knows how to do a job until he has actually done it, if only in a small way."

GENERAL FECHET talked on the effectiveness of airplanes as a weapon of warfare. He said, in part, as follows:

"The work of the Ordnance Department, in a large part, was responsible for the effectiveness of airplanes as a weapon of warfare. The Ordnance Department in developing its 2,000 and 4,000-pound bombs had far surpassed bombs of other nations. A 10,000-pound bomb had been developed but as yet aircraft had not been brought to the point where they could carry a bomb of this size. However, one squadron of airplanes could fire in salvo 200,000 pounds. One wing, could develop in a short time fire power equal to an entire division of Infantry."

General McCoy told about the work of the Fourth Corps Area, showing how he represented one of the biggest businesses of the South. He said that the work done by the Army Engineers on the rivers and harbors alone represents a tremendous business and when the National Guard, Reserve Officers and other units, flying fields, forts and posts were considered, the activities in the area are of vast importance."

The Committee on Arrangements, composed of Lt. Colonel Frank H. Crockard, Colonel George Morrow, Major S. F. Clabaugh, Captain D. N. Hauseman, 1st Lt. R. J. Stockham, and Mr. Erskine Ramsay, was given a vote of thanks by the President of the Post for their effort in making the meeting a success. The nominating committee, composed of Mr. Erskine Ramsay, Herbert E. Smith, Herbert Ephgrave, suggested reelection of all the officers of the Birmingham Post. The recommendation was adopted enthusiastically and unanimously.

### Milwaukee Post

THE principal address at the fall meeting of the Milwaukee Post, Army Ordnance Association, which was held at the Milwaukee Athletic Club December 2, 1931, was given by Capt. Stewart E. Reimel, Ord. Dept., U. S. A., who is stationed at the Rock Island Arsenal. The meeting was held jointly with the Milwaukee Section, Society of Automotive Engineers, and was preceded by a dinner at which 133 members were in attendance. Col. William W. Coleman, Vice-President of the Army Ordnance Association and President of the Milwaukee Post, presided and in presenting the speakers of the evening stressed the compatibility of preparedness and the desire for peace. He urged that the military forces be properly equipped and that peacetime tests and advancements of munitions be given the encouragement and assistance they require.

Captain Reimel spoke on ordnance automotive equipment and explained in detail the characteristics of the latest developments in this field. His discussion embraced the entire range of mechanized matériel including both vehicles and the newer types of armament to be used with them.

Following Captain Reimel's address, a demonstration was given using the fuel-testing motor developed by the Coöperative Fuel Research Committee of the Waukesha Motor Company under the direction of Mr. H. L. Horning and Mr. Arthur W. Pope, Jr. It was explained that with this machine there has been a definite means established of measuring the "knock" of a motor car fuel.

The officers of the post who were in charge of arrangements for the meeting are, in addition to Colonel Coleman, Maj. Eric H. Lichtenberg, vice-president; Col. James G. Cowling, Col. Herbert V. Kohler, Maj. Roger Sherman Hoar, directors; and Lieut. C. W. Laumann, Secretary-Treasurer.

### Maj. Raphael R. Nix

MAJ. RAPHAEL R. NIX, Ord. Dept., U. S. A., executive officer of the Chicago Ordnance District and secretary of the Chicago Post, Army Ordnance Association, died suddenly at Fort Sheridan, Ill., December 9, 1931. An officer of unusual talents, Major Nix was a charter member of the Army Ordnance Association and by reason of his service in connection with industrial planning activities of the War Department was considered one of the most versatile officers on this subject. He had only recently undertaken the duties of executive officer of the Chicago Ordnance District. His death is a great loss to the department and to the Association.

Born at Greenville, S. C., in 1886, Major Nix was graduated from Tulane University in 1906 and from the United States Military Academy in 1909. He was a graduate of the Army War College, the Command and General Staff School and the Army Industrial College, and was on the General Staff eligible list. His service in the Ordnance Department began in 1910 by detail from the Coast Artillery Corps. He served at the Frankford Arsenal during that year and later was stationed at the Sandy Hook Proving Ground and at the Rock Island Arsenal. Upon his return to the Coast Artillery he was stationed at Fort Howard, Md., and in the Panama Canal Zone.

He was redetailed to the Ordnance Department with the rank of captain in 1915 and served as armament officer at Springfield Armory. Promoted to major, Ordnance Department, October, 1917, and lieutenant colonel, Ordnance Department National Army, January, 1918, he was commanding officer of the Manila Arsenal until 1921. Later he served as an ordnance representative on the Coast Artillery Board, and commanding officer, Curtis Bay Ordnance Depot. Following a tour of duty as a student officer at the Command and General Staff School and the Army Industrial College, from which he was graduated in 1925, he served as ordnance representative, Office of The Assistant Secretary of War until 1928. Major

Nix was graduated from the Army War College in 1929 and prior to his last station at Chicago he was Ordnance Officer, 3rd Corps Area, until June, 1931.

### William H. O'Gorman

ANNOUNCEMENT of the death of William H. O'Gorman, Assistant Director of Sales, Smokeless Powder Department, E. I. duPont de Nemours & Co., will come as a shock to a large circle of friends including many of the officials of the Ordnance Department and members of the Army Ordnance Association.

Bill O'Gorman, as he was affectionately known, had been connected with the duPont Company for many years, having entered its employ in 1916 as supervisor at the cap works at Pompton Lakes, N. J., where he remained until February, 1921, when he was engaged on the adjustment of war claims. He joined the Military Sales Division in the same year where he remained until the time of his death.

Born in New York City September, 1889, he attended the New York public schools and the Townsend Harris Hall High School and was graduated from the College of the City of New York in 1911. He also attended Columbia University. He was highly regarded by his business associates and in his important work with the company he represented he made many enduring friendships. He will be missed especially by those of the military explosives group of the services who came in contact with him.

### Necrology

Since publication of the last issue of ARMY ORDNANCE notice has been received of the death of the following members of the Association: Byron W. Benedict, Lansdowne, Pa.; Thomas Denny, New York, N. Y.; A. C. Dinkey, Philadelphia, Pa.; W. J. Hagman, Philadelphia, Pa.; Reuben Hitchcock, Cleveland, Ohio; Charles H. Jockmus, Ansonia, Conn.; Anson Mark, Chicago, Ill., and Richard Sylvester, Wilmington, Del. To the relatives and friends of these deceased members the Association extends condolences.

### New Members

The following have been admitted to membership in the Association since the last issue of ARMY ORDNANCE: William E. F. Appuhn, Woodhaven, L. I., N. Y.; Floyd P. Archer, Wilkes Barre, Pa.; Martin W. Baden, Winfield, Kansas; Cecil E. Bales, Ironton, Ohio; R. H. Born, Stanford University, Calif.; R. T. Brooke, Birmingham, Ala.; William H. Carson, Norman, Okla.; R. E. Choate, Cedar Rapids, Iowa; George W. Collins, Woodbury, N. J.; W. A. Currie, Birmingham, Ala.; William J. D'Espinosa, Philadelphia, Pa.; W. H. Dole, Stanford University, Calif.; Theodore M. Dunlap, Chicago, Ill.; Henry F. Glunz, Saratoga Springs, N. Y.; Ben James, Stanford University, Calif.; Albrecht J. Janssen, Chicago, Ill.; Kelsey H. Jewett, Buffalo, N. Y.; James A. Kelley, Stanford University, Calif.; Frank F. Koehler, New York, N. Y.; James F. Loughlin, Milwaukee, Wis.; C. H. Maier, Boston, Mass.; Edwin S. Mardock, Stanford University, Calif.; W. Sherwood Marvis, Palo Alto, Calif.; Carl Naumann, Philadelphia, Pa.; Clifford A. Patch, Stanford University, Calif.; Jacob Ribakoff, Worcester, Mass.; Daniel G. Richardson, Stanford University, Calif.; Gilbert I. Ross, Belmont, Mass.; Everett H. Runkle, The Dalles, Ore.; Robert H. Savage, Stanford University, Calif.; Clarence E. Sperry, New York, N. Y.; Kenneth C. Stuart, Lancaster, Pa.; Harry L. Swicegood, North Abington, Mass.; Francis H. Taylor, Stanford University, Calif.; W. F. Tynes, Birmingham, Ala.; Robert A. Uihlein, Milwaukee, Wis.; Leslie T. Vice, Vallejo, Calif.; H. D. Whitfield, Middleburg, Va.; Vernon J. Wright, Stanford University, Calif.; John F. Young, York, Pa., and Walter Zober, Brooklyn, N. Y.


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## Professional Notes

**Meeting of S. A. E. Ordnance Advisory Committee**

THE semiannual meeting of the Ordnance Advisory Committee, Society of Automotive Engineers, was held in New York, January 14 and 15, 1932, coincident with the annual meeting of the Society. The meeting of the committee, the twenty-fifth gathering of the group which has been functioning since 1919, was called by Lt. Col. A. F. Masury, Spec. Res., chairman, who is vice-president and chief engineer, International Motor Company, New York.

The agenda for the meeting included consideration of the designs of light tanks and combat cars, recent designs of rubber jointed tracks, light removable half tracks for six-wheeled vehicles, the question of development and fabrication of armor plate bodies of combat vehicles, discussion of the results of tests of the Convertible Medium Tank T3, the commercial possibilities of certain European developments, the possibilities of commercial six-wheel-driven trucks for military work, the use of commercial units such as clutches, transmissions, etc., in special military vehicles, and discussion of the problem of low speed operation of combat vehicles in column.

The committee visited the George M. Brewster plant near Hackensack, the Standard Oil Tidewater Delivery station at Newark, the Development Department of the same company at Bayway, and the operations of the Tompkins Bus Company.

The members of the committee, in addition to Colonel Masury, are:

Col. H. W. Alden, Ord. Res., chairman of the board of directors, Timken-Detroit Axle Company, Detroit, Mich.; Col. William G. Wall, Ord. Res., consulting engineer, Indianapolis, Ind.; Maj. Emil F. Norelius, Ord. Res., chief engineer, Monarch Tractor Corporation, Springfield, Ill.; Maj. A. W. Herrington, Qm. Res., Marmon-Herrington Company, Indianapolis, Ind.; Mr. P. E. Holt, vice-president and director, Caterpillar Tractor Company, Stockton, Calif.; Mr. G. A. Green, vice-president in charge of engineering, General Motors Truck Corporation, Pontiac, Mich.; Mr. G. A. Round, engineer, the Vacuum Oil Company, New York, N. Y.; Mr. Floyd C. Hecox, engineer, Cadillac Motor Car Company, Detroit, Mich.; Mr. John F. Winchester, general superintendent of motor equipment, Standard Oil Company of New Jersey, Newark, N. J.; Mr. Arthur J. Scaife, engineer, The White Company, Cleveland, Ohio; Mr. H. T. McDonald, engineer, Caterpillar Tractor Company, Peoria, Ill.

The following personnel of the Ordnance Department participated in the deliberations:

Col. E. M. Shinkle, commanding officer, Aberdeen Proving Ground, Md.; Lt. Col. C. M. Wesson, chief of Technical Staff, Ordnance Department, Washington, D. C.; Lt. Col. Norman F. Ramsey, Headquarters Second Corps Area, Governors Island, N. Y.; Lt. Col. C. G. Mettler, New York District Ordnance Office, New York, N. Y.; Lt. Col. J. H. Burns, chief of Artillery Division, Manufacturing Service, Ordnance Department, Washington, D. C.; Maj. Robert Sears, chief of Automotive Proof Department, Aberdeen Proving Ground, Md.; Maj. R. L. Maxwell, chief of Artillery and Automotive Division, Technical Staff, Ordnance Department, Washington, D. C.; Capt. H. A. Nisley, Ordnance Inspector, U. S. Wheel Tracklayer Corporation, Rahway, N. J., and Capt. John K. Christmas, chief of Automotive Section, Artillery Division, Manufacturing Service, Ordnance Department.

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### Centrifugal Cast Cannon

THE Ordnance Department of the United States Army is keeping abreast of modern developments in the iron and steel industry and is a large factor in the experimental and research work of new methods of production.

At present practically all cannon are steel forgings. Considered metallurgically, forgings for use in cannon must be of exceptional quality, requiring great skill and care at every step in their manufacture.

The ingot which is cast from the molten metal must be large enough to permit at least a 2 to 1 reduction in area of cross section during forging. It must be heavy enough to allow a discard of 35 per cent of its total weight to insure sound, clean metal in the forging.

Thus, an ingot weighing 3,000 pounds will have 30 per cent or 900 pounds discarded from the top and 5 per cent or 150 pounds discarded from the bottom. This leaves only 1,950 pounds of metal good enough to be used and represents a total loss of 1,050 pounds of metal.

For cannon of less than 10-inch bore the forging must be made solid. The boring of a hole through such a forging, which may be about 45 feet in length, presents a machine operation of great difficulty. Producing a satisfactory gun forging is a tedious and expensive operation, perhaps the most difficult of any similar manufacture.

There has been recently developed at the Watertown Arsenal an application of the centrifugal casting process to the manufacture of steel cannon. A mold, made up to the approximate interior dimensions of the finished gun, is mounted for rotation in a machine so that its longitudinal axis is horizontal. Both sand and chill molds have been used.

The latter perform better and are made up from single iron castings, requiring very little attention during use. One end is closed by a simple stopper with a hole in it to provide a passage for the escape of gas. The other end is closed by a bushing to receive a stationary pouring spout.

To make a casting, the mold is rotated at the desired speed. The molten metal is poured, through a runner box and the spout, into the mold. Speed is maintained on the mold long enough to insure complete solidification, when the mold is stopped.

The runner box and spout are taken away, the bushing is removed, and the casting, having shrunk away from the mold, is easily slid out. With an adequate supply of molten metal, experience shows that one mold can turn out two castings per hour weighing under 1,000 pounds, or one casting per hour weighing between 1,000 and 4,500 pounds.

These castings are in every way equal to a rough turned and bored forging. In fact, from a metallurgical point of view, they have marked superiorities.

The casting may be made within ½ inch of the finished outside diameter of the gun and will be perfectly round. In length it will be longer than the finished piece only by enough to provide metal for testing or subsequent manufacturing operations. It has a hole through the center that is accurately straight and may be made approximately to any given size. This result is obtained within a few minutes after the metal existed in the molten state.

The superiorities over a forging are consistent and marked. The centrifugal force under which the metal cools forces all gas and impurities into the central hole, resulting in cleaner, denser metal. This same force leaves stresses set up in the metal for which designers have been striving for years.

Most important of these is compression at the bore; the result aimed at by building up guns from a number of tubes, jackets, and hoops shrunk together. It is found that no "grain" exists, as it does in forgings. Properties of the metal are as good, or

better, in a transverse direction than in a longitudinal direction. This condition, impossible of attainment in a forging, is desirable in a gun.

From a chemical standpoint also, the element giving strength to steel, is found to be greater in amount at the bore than at the exterior. Thus, the strongest material is at the bore where it is needed.

It is clear that the process is ideally adapted to gun manufacture from every standpoint—metallurgical, technical, and economical. The development has been the greatest contribution to the art of gun making since General Rodman first successfully cooled the bores of cast-iron cannon during solidification of the iron.—S. L. CONNER, *1st Lieut., Ord. Dept., U. S. Army, Watertown Arsenal.*

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**Molybdenum**

MR. W. H. PHILLIPS, metallurgist and vice-president of Molybdenum Corporation of America, Pittsburgh, Pa., gives the following interesting account of molybdenum—a metal of growing importance in national defense—in a recent issue of *Research Narratives:*

"Greeks said 'molybdenum' when they meant the stuff we call lead. They also applied this name to other substances that looked like lead. By the ancients the metal we now distinguish as molybdenum was considered to be some derivative of lead, from which it differs greatly. This error is easily understood when one realizes that the rarer metal is most commonly found in nature in the form of molybdenum sulphid, a compound of molybdenum and sulphur, for which the chemist's symbol is $MoS_2$, a soft, flakey, black substance resembling graphite.

"Sargent secured this information from Dr. O. Kochi, Faculty of Technology, Imperial University of Tokyo. Years ago a German steel expert analyzed a part of a sword blade made by a famous Japanese artist, Masamune (1330 A. D.) and discovered in it the rare element molybdenum, doubtless as an impurity. This led the discoverer to ascertain the source of Masamune's alloy iron. Thereupon he purchased this iron in large lots, much to the surprise of the Japanese. Later, when they analyzed captured German cannon, they decided where a part at least of the molybdenum ore was obtained.

"Discovered by Scheele in 1778 in the form of an oxid, molybdenum was first separated as a metal by Hjelm in 1782. It is now produced commercially by hydrogen reduction of the oxid, pure oxid being obtained from ammonium molybdate. The resulting metallic powder is sintered, forged and rolled into desired shapes. When pure, molybdenum is soft, white and ductile.

"During the last thirty-five years, a great deal of research was done in Europe, Japan and the United States. Many characteristics were developed. Not until the World War did it come into prominence; it was extensively used as an alloying element in light armor plate, helmets and Liberty engines because of great increase in strength and toughness imparted to steel.

"Even in war time its application was limited, due to uncertainty of the supply and high cost. In the last few years, large deposits of ore have been discovered in the United States. There are deposits, of varying richness, in many parts of the world, but the largest and richest known are in this country. Commercial deposits are found ranging in richness from ½ of 1% up to 8% or 10% $MoS_2$. After grinding and flotation, the ore is concentrated to about 80% $MoS_2$. From these concentrates commercial products are made. Rapid lowering of cost by increased production has resulted in a large portion of the world's requirements being supplied from American mines. This important element could not be shut off from this country in times of stress as could some alloying elements used in steel.

"It has been said that, excepting carbon, molybdenum is the


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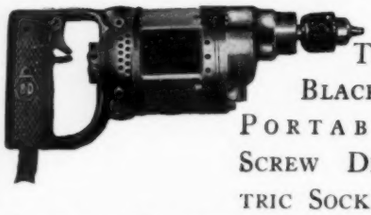

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most potent alloying element added to steel. Molybdenum can be substituted for tungsten in the ratio of 1 for 2. In quantities generally used in steel, molybdenum for the most part goes into solution with the iron, though when present in percentages of over 1%, or when considerable quantities of chrome or manganese are present, it forms a double carbide. It is also probable that a definite compound of molybdenum and iron is formed when cooled through the critical range. Used in percentages as low as one-tenth of one per cent, or two pounds to the ton, it has shown marked tendencies in resisting corrosion. In percentages up to 10% it offers a possible substitute for the tungsten high-speed tool steels.

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"The pure metal is extensively used in the incandescent and radio bulb industry. In the forms of salts and oxides it is used in the chemical and dye industries. According to a booklet, 'Rare Metals': 'To say that the air or ether carries the radio broadcast wave is true, but it's a certain metal sealed tight in tubes which puts the wave on the air, and then in different tubes, recaptures it, to be turned back into music or words. This metal is molbydenum—the metal that talks.' Literally thousands of miles of molybdenum wire, drawn through diamond dies, have been used in the radio industry.

"Thus do we find modern industry, engineering and research making a place for a material known for a century and a half, but little used until within the last few years."

### The Thompson Submachine Gun

THE Thompson caliber .45 submachine gun, much used as a riot gun by police, is receiving attention from various branches of the Army. The Cavalry has already adopted it as an auxiliary weapon for their armored cars, and have issued regulations governing its use in the training regulation covering armored-car marksmanship. It has uses in the armored car both on ground targets and low-flying aircraft.

The Infantry is testing the weapon at Ft. Benning, and while no information is available as to its potential uses to that branch, it is thought that it may find a place as an auxiliary tank weapon. The submachine gun weighs slightly over 8 pounds, which is around the weight of the Springfield rifle now in general use as the Army rifle. Its effective range runs up to about 600 yards, and its most effective range is about 300 yards. It is not thought that the weapon could ever replace the automatic rifle, but it is thought that it may have some definite use.

The Field Artillery, also, has this submachine gun under consideration, and probably will at some time conduct tests to determine its possible value. It is thought at present that it might be used to advantage to protect exposed batteries from sudden raids, and also from low-flying planes.

### New Primer for Antiaircraft Ammunition

THE completion and final adoption of an improved design of primer for antiaircraft ammunition is about to be realized. The new type primer involves the use of the same primer head as is standard for the 100 gr. percussion primer, which is used in these guns. The only change, then, will be the substitution for the present "drawn" body of a longer primer body made of brass tubing. Such a simple solution for the ignition problem is considered gratifying by the Ordnance Department, since no cartridge case modifications will be necessary and since the longer body made of tubing costs scarcely more than the short body made by the drawing process.

AOA

## Digest of Ordnance Patents

THE following digest of recent ordnance patents is by W. N. Roach, Chief, Patent Branch, Office of the Chief of Ordnance. Letters patent have been issued:

To Bryon C. Goss No. 1,819,090 for a gas-containing projectile or long-range tear gas shell. In this invention the gases forming the compounds are contained in a frangible casing which also contains an explosive charge and a time fuze which is ignited by the propellent charge.

To Capt. Lewis M. McBride, C. W. S., U. S. Army, and Frank B. Hale, Chemical Warfare Service, No. 1,819,106 for a method of shell construction. Specially perforated baffles are provided within a shell causing the liquid to rotate therewith and so avoid the undesirable effect due to inertia of the liquid.

To William H. Dehn No. 1,819,456 for a process of impregnating plant tissues with sodium nitrate for explosive purposes. In this process two parts by weight of sodium nitrate are added to one part by weight of water and heated until all the salt has passed into solution. Comminuted vegetable matter, as for instance sawdust, is then added and the heated solution is run through a screen.

Also to Mr. Dehn No. 1,819,457 for a colloided starch explosive and process of manufacturing the same. In this process, starch and sodium nitrate are gelatinized with water and then dried.

William H. Dehn has also been granted patent No. 1,819,458 for a propellent explosive consisting of ammonium nitrate, colloided starch and colloided nitrocellulose.

To Llewellyn J. W. Jones, assignor to James F. O'Brien, No. 1,820,568 for an explosive composition which contains trinitrotoluene and orthonitrotoluene.

TO Louis M. McBride No. 1,812,010 for a shell containing chemicals made up of sections which may be readily formed by a punch press.

To Maj. H. H. Zornig, Ord. Dept., U. S. Army, No. 1,813,106 for a special form of safety device for fuzes which is released by the combination of set-back and centrifugal force.

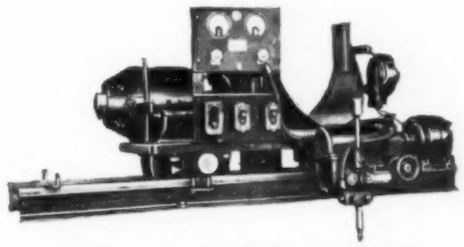
To Gilbert E. Rogers and John M. King, Picatinny Arsenal, No. 1,814,059. This patent covers a combination fuze for drop bombs and provides a special safety mechanism.

To Eugene Schuler, assignor of one-half to the firm Josef Schuler A. G. Erste Ungarische Stahlschreibfeder-, Federhalter- Und Indigocopierpapier-Fabrik, and three-tenths to Joseph Benke, No. 1,817,273 for a safety projectile for gun practice and gun barrels suitable for the same. This invention contemplates the provision of a lead projectile cemented to the front end of a paper shell cartridge in a gun barrel having a loaded chamber so shaped to insure that the cylindrical front end of the projectile will be jammed into the entrance of the draw-channel of the gun barrel.

To Robert J. Anderson, assignor to National Fireworks, Inc., No. 1,817,503 for an aerial flare. The invention provides for delaying ignition of the flare until it has dropped a predetermined distance. It also provides a means of locking the ignition mechanism.

To Roy Walter James No. 1,817,377 for a projectile so constructed as to eliminate the formation of a vacuum at the rear end of a missile when in flight.

To Arthur Hough No. 1,822,290 for an explosive containing nitrated vegetable parchment.

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TO Joseph D. McNutt, assignor to Winchester Repeating Arms Co., reissue No. 18,137 for a priming mixture containing basic lead nitrate as an oxidizing ingredient.

To Lewis R. Stuyvesant No. 1,812,905 for a safety device for firearms which provides a form of latch intended to hold the slide of an automatic pistol.

To Joseph E. Steward No. 1,814,975 for a vertically adjustable gun sight.

To John D. Pedersen No. 1,815,524 for a reversible clip for ammunition. This invention covers a clip having inturned ends the inturned end at one side being shorter than that at the other so that one diagonal distance from end to end of a clip will be shorter than the other to render it impossible to load the clip except in a proper position to be fed either end first into the gun.

To John H. Redfield No. 1,816,195 for a telescope mounting for guns. The invention relates to a specific form of mounting for the telescopic sight which is more rigid than the usual mounting.

To Luigi Savani, assignor to Societa Italiana Ernesto Breda Per Costruzioni Meccaniche, No. 1,816,265 for portable firearm for casting bombs and grenades by means of ordinary bullet cartridges. A rifle having a large grenade barrel to the gas passage is used. The barrel is adapted to receive the gases flowing from the cartridge case in rear of the bullet.

To Christopher H. Bierbaum No. 1,817,058 for an arm with flared channels at the muzzle and between the lands. The purpose is to prevent upsetting or wabbling of a bullet the base of which is not perpendicular to the axis.

To Oscar V. Payne, assignor to Auto-Ordnance Corporation, No. 1,817,321 for a method for slowing down the rate of fire of a machine gun. This is accomplished by adding weight to the actuator.

JOSEF NICKL, assignor to Mauser-Werke A. G., No. 1,818,086 for a safety device for firearms consisting of a lever which allows the hammer to be cocked at all times. When the lever is drawn to "safe" an extension on the lever is in the path of the hammer and prevents it from moving forward to fire the cartridge.

To William A. Caruth No. 1,818,381 for a gun sight having a series of lugs spaced apart to provide a vertical series of horizontal sight openings.

To Jonathan Edmund Browning, assignor to J. E. Browning Co., No. 1,818,984 for an automatic firearm. The main object of this invention is the provision of means for insuring a proper relative timing of the recoil and counterrecoil movements of the barrel extension and the breech bolt and also the provision of means for locking the breech bolt in rearmost position when the last cartridge has been fired from the magazine or clip.

To Emanuel Holek, assignor to Ceskoslovenska Zbrojovka Akciova Spolecnost V Brne, No. 1,821,385 for a gas-operated charging device for small arms.

To Karl Danthine No. 1,821,463 for a machine gun. This invention contemplates making the rear portion or guide of a machine gun barrel, such as is used in the Maxim machine guns, of a separate piece so that when the barrel has to be changed the new barrel need not contain the expensive rear guide part.

To John D. Pedersen No. 1,821,526 for a clip to hold a double row of cartridges in staggered relation which clip may be inserted into the gun either end first. The novelty resides in the fact that the side of the clip engages the stack of cartridges with a clamping pressure.

To Capt. Richard C. Coupland, Ord. Dept., U. S. Army, No. 1,819,769 for a compact gun sight the parts of which are thoroughly protected from accidental injury. The operating screws are novel in that they are coaxially mounted.

## Book Reviews

**Sheridan—A Military Narrative.** By Joseph Hergesheimer. New York: Houghton Mifflin Company. 1931. $4.00.

THIS is not a biography of General Philip H. Sheridan, great cavalryman of the American Civil War. It is, as its title indicates, a narrative of the three crucial campaigns in which Sheridan played a master part. Seldom does one find so clear and comprehensive an account of military operations woven about a dominant character as is presented in this painstaking work of Hergesheimer. No wonder that Grant ranked Sheridan with Napoleon and Frederick and other great commanders of history for Sheridan never finally lost a battle. With defeat facing his troops after a successful conquest of the Shenandoah Valley he returned to his forces and inspired them to the attack and victory.

Hergesheimer's treatment of necessity embraces the three great episodes of Sheridan's part in the war: "The Mountain," Chickamauga and Missionary Ridge; "The Valley," Winchester, New Market and Harrisonburg; "The Plain," Petersburg and Appomattox. In all he displayed the characteristics of the leader whose resourcefulness and ability (marked by "passionate cursing and a low-voiced impressive tranquility of confidence") which rank him with the premier cavalrymen of all time.

On the lighter side readers will be impressed with the following quotation typical of the style and method of the author:

"On August 17, of the year 1870, General Philip Henry Sheridan was in a dilemma: on the following day he was to be received by the King of Prussia at the battle of Gravelotte, and General Sheridan could not decide what it would be proper for him to wear. He had arrived late in the afternoon at Pont-à-Mousson, from Remilly, in a hay wagon, and Count von Bismarck had received him in the undress uniform of colonel in a cuirassier regiment. The difficulty was created by the General's uncertainty about his present status in Europe—he had explained to President Grant, before leaving the United States, that he wished it to be unofficial; and so he did not know if, appropriately, he could appear in uniform. He asked the Count von Bismarck, finally; and the Count, upon profound deliberation, gave it as his opinion that the General might wear his undress uniform. But, since he was a non-combatant, without his sword. In a more practical spirit, General Sheridan remarked that he had not had time to provide himself with transportation, and the Count von Bismarck replied that, four o'clock the next morning, he would not only bear the General to the battle-field in his own carriage, personally present him to the King, but further require one of his staff officers to provide General Sheridan with a horse."

We agree that Mr. Hergesheimer has undoubtedly constructed a standard book on "little Phil" whose stature grows as the narrative progresses.

**The Unknown War.** By Winston S. Churchill. New York: Chas. Scribner's Sons. $5.00.

THE history of the war on the Eastern Front is a saga which has received but little attention from other historians, but which, in the hands of Winston Churchill, becomes a tale of flaming interest. The fighting on the Western Front has heretofore absorbed everyone's interest, but here is a tale which, in

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the magnitude of its development, in the presentation of the gigantic struggle which endured from August, 1914, to March, 1917, is far beyond anything so far written to picture the cataclysm which utterly ruined three empires, where the fabrics woven by the looms of the Hapsburgs, the Hohenzollerns and the Romanov's were torn to shreds and obliterated.

Victories and defeats follow each other in rapid succession; the perils and toils, the passions and sufferings, the sweat and the tears, all bedewed with the blood of millions of men, cover the pages of this tale with an indelible clarity which can never be expunged. The privations endured for the sake of loyalty were all endured in vain; all was given, but nothing was gained while men either floundered wearily in mud, perished in snowdrifts or starved in the frost. A tale of how Central Europe, blasted into fragments and expiring in agony, arose again, but in an unrecognizable form. The battles fought on the West seem but small affairs when compared with these, where movements were ceaseless, where a stalemate had not obtained.

The persons playing out this drama are depicted with faithful exactitude; the style of presentation is of the usual Churchill order, extraordinarily clear and verile in its every part; the 381 pages of the book will be read with an awakened interest after the surfeit of literature which the Western Front has given us, and the reader will hesitate to put the book aside until he has finished with its last word.

**The Modern Shotgun, Vol. II—"The Cartridge."** By Maj. Gerald Burrard. New York: Charles Scribner's Sons. $5.00.

THIS splendid contribution to the art, as in the case of the first volume of the series, "The Gun," clearly demonstrates a most intimate and analytical knowledge of the subject treated in these volumes. Our author's delightful style transforms a text-book into a novel without sacrificing any of the essential features.

Problems including questions of explosives used in both powders and primers are dealt with from the point of view of the practical sportsman who is chiefly interested in the why and wherefore of his cartridge. The "bug-a-boo" of "After Rusting" in firearms is exposed and while the facts may not be pleasing to the proponents of non-corrosive primers for shot shells the chemistry of the subject is hard to refute. In this connection Major Burrard has made acknowledgment of Dr. Wilbert J. Huff's thesis on "After-Rusting in Firearms" (1920).

Separate chapters are devoted to each component of the completed round and those on pressures, velocities, and recoil are amply supplemented by valuable ballistic tables and graphs.

Truly, these volumes cover in detail subjects on which complete and accurate information has been heretofore too insufficient and the author's painstaking research is heartily welcomed. The concluding volume of this series, "The Gun and the Cartridge," is eagerly awaited.

**Decatur.** By Irvin Anthony. New York: Charles Scribner's Sons. 1931. $3.50.

THE stirring life of Stephen Decatur by an author who knows ships and the sea. The 308 pages of this biography are filled with incidents which should make a naval man's heart beat a little faster with the thought that the romance of sea battles as fought in Decatur's days no longer exists. The battle between the UNITED STATES, commanded by Decatur, and the crack British frigate MACEDON, commanded by Captain Carden, is an epic, and should remain in the memory of our Navy for all time, since the MACEDON was captured without boarding, Decatur's trained gunners, once having their guns on the target, calmly "took the British frigate to pieces."

Decatur thus founded modern gunnery practice, although it was many long years before other eyes saw as his.

Before this action, however, Decatur had subdued the Tripolitan pirates, his success here also being tinged with romance. He entered the service at the age of nineteen, and for seventeen years he scarcely set foot ashore. Finally made one of the three Naval Commissioners, he helped in no uncertain manner to lay the foundation of the American Navy, his intense activity being brought to an end, when only forty-one years of age, through a bullet fired by his antagonist, Capt. James Barron, in a useless, foolish duel at Bladensburg, the dueling ground so often mentioned in history.

Here is biography, written with verve and authority, which will be enjoyed by all readers of history or lovers of the sea.

**"February 1917."** By Aleksei Tarasov-Rodionov. New York: Covici-Friede. 1931. $3.75.

THIS is a chronicle of the first revolution, so graphically delineated that one almost imagines being present during those days which eventually gave birth tc the Union of Socialist Soviet Republics. The author was a machine-gun officer in the Czarist Army, who hastened to Petrograd to take part in the storm which rumbling thunder had predicted for some weeks. The story is a personal one throughout, which makes it most interesting, and the author's discussions and troubles with other revolutionists plainly show that where there are many minds there is no absolute goal to be achieved. The weakness and vanity of Kerensky, who was to lead the Russian proletariat to a higher plane, is vividly painted. The arrival of Lenin from Switzerland and his early efforts to bring some order out of the chaos provided by these many minds is graphically presented. In fact, a roaring crescendo passes over every one of the 378 pages, and when once taken in hand the reader will reluctantly lay the book aside for other duties.

Every page is alive with events which toppled a throne into dust and gave rise to one of the greatest experiments in government the old world has ever seen. The confusion and turmoil following initial success, the attempt at counter-revolution, the policies of the self-seekers, with the concomittants of idealism, rancor, demagogery and ambition, pass across the pages in a manner which could be presented only by one who had lived through and acted in the struggle.

The reviewer has read a number of books bearing on this subject, but in none of them was found such an interesting presentation as is found within the covers of this volume. The book lays no claim to literary pretensions, but aims only to present the facts in a forceful and terse picture, and in this the author has had remarkable success. Read this book; you will never regret the time spent on it.

**Symposium on Welding.** American Society for Testing Materials. Philadelphia. Cloth $1.75.

THIS book comprises the papers which were presented in a Symposium on Welding held at the second Regional Meeting of the Society, Pittsburgh, March 1931. The Pittsburgh section of the American Welding Society coöperated in arranging the technical program.

There were eleven papers given in the symposium and the discussion which resulted has been included in the book. Special attention is paid to characteristics and interrelation of newer steel welding processes. A classification of processes and uses is given from the function standpoint. The various methods of gas and electric-arc welding applicable to aluminum are discussed. This involves types of joints used, alloys welded and merits of the methods. Fusion welding of high-carbon and

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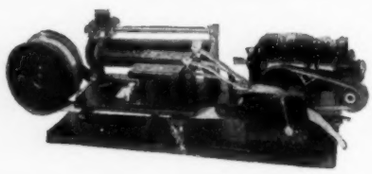

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special steels is discussed. Specifications for welding and the necessity of welding materials' standardization are emphasized.

A major portion of the symposium treats with the testing of welds and welded products. One author discusses extensively the stethoscope method of weld testing. Magnetographic inspection and magnetic weld test meters are described as well as other types of magnetic testing apparatus. The utilization of X-ray equipment for welding as carried out at the Watertown Arsenal is fully discussed by Lieut. Col. G. F. Jenks, Ord. Dept., U. S. Army. An extension of X-ray testing, namely, the use of gamma rays, is described by Prof. G. E. Doan, of Lehigh University.

**The Reckless Duke.** By Sir Philip Gibbs. New York: Harper and Brothers. $4.00.

A GRAPHIC and romantic story covering the life of one of the world's children of fortune, one whose infatuation for Anne of Austria, Queen of France, made him an actor in the "Three Musketeers," Dumas' immortal novel. It appears, however, that D'Artagnan, who went to London to obtain the Queen's diamond studs from Buckingham, should have asked for the Queen's garter. George Villers, the first Duke of Buckingham, brought to the attention of King James I by politicians desirous of displacing the then Favorite, the Earl of Somerset, was only twenty-one years of age when he started his meteoric ascent of the ladder of fortune. This ascent was so rapid that in a few years he gathered more honors from a doting king than a dozen others might acquire in twice the time. He made friends and, of course enemies, but in spite of his many faults he had an extraordinarily good heart for a man of his period. Although impetuous and quick to anger when his personal interests were attacked, Gibbs shows, through newly discovered documents, that Buckingham was by no means the giddy-pated fool usually described in too many histories. He was a zealous and industrious servant of two Stuart kings, and was disinterested in all matters of State which did not affect his personal position and, what must have been a strange phenomenon of the period in which he lived, was absolutely without a corrupt love of gold, something which could not be said of most other favorites who were rather a curse to their country.

Gibbs shows him to be a man of great physical beauty (which attracted King James), amazing charm, of a generous disposition, and fearless of the devil himself, rushing like a hurtling comet through a period redolent with decadent luxury, only to meet his death by a "ten-penny" knife in the hands of a captain made reckless by brooding over his lack of employment and his arrears in pay.

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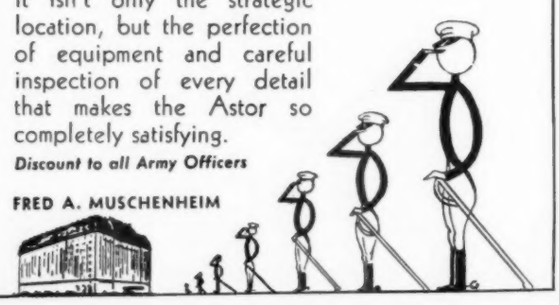
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